SEP 21'44 W

1 1 7

The INSTITUTION of PRODUCTION ENGINEERS

JOURNAL

(*August* 1944, *Vol. XXIII, No. 8, Ed. B*)

CONTENTS

EXTRAORDINARY GENERAL MEETING—OFFICIAL NOTICE

SOME PRINCIPLES OF PRODUCTION CONTROL AND THEIR APPLICATION TO STEEL FOUNDRY WORK
by A. B. Lloyd

SPECIAL EQUIPMENT TO FACILITATE THE EFFICIENT USE OF DIAMOND TOOLS
by Dr. G. Schlesinger and Dr. D. F. Galloway

THE RESEARCH DEPARTMENT ACTIVITIES

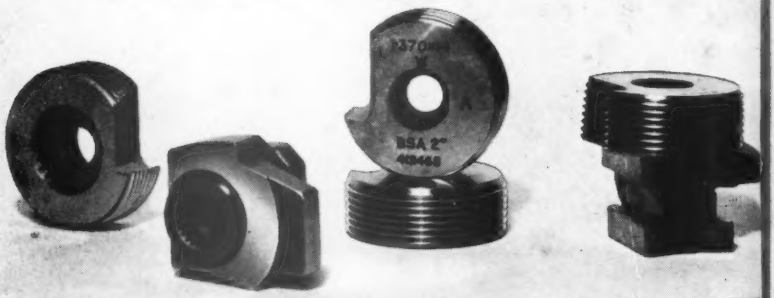
PUBLISHED BY THE INSTITUTION 36, PORTMAN SQUARE, LONDON, W.1

All rights reserved *Price 5/-*

B.S.A.-NAMCO

Made in England

CHASERS AND BLOCKS



Chasers and Chaser Blocks for use in the well known "Namco" Diehead, are now manufactured by B.S.A. Tools Ltd.

Available for short delivery in a wide range of sizes. Details on request.

Manufacturers

B. S. A. TOOLS LTD.

Sole Agents

BURTON GRIFFITHS & CO. LTD. BIRMINGHAM, ENGLAND.

HALIFAX
ENGLAND

THE WORLD'S LEADING
DRILLING, BORING & MILLING
MACHINE SPECIALISTS

WHILST playing our full part in the war effort we look to a happier future and welcome any opportunity of contacting customers old and new.

In peace or war our motto is SERVICE, and we are happy at all times to offer advice on machine tool problems and the application of ASQUITH machines to specific jobs.

SOLE DISTRIBUTORS FOR THE BRITISH ISLES:

DRUMMOND (SALES) LTD.

KING EDWARD HOUSE
NEW STREET, BIRMINGHAM, 2

ESTABLISHED 1865

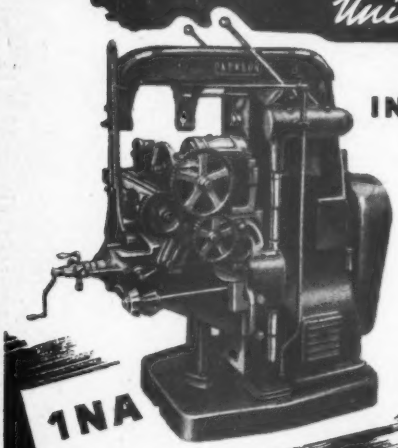
ASQUITH OVERSEAS SALES AND SERVICE DEPOTS THROUGHOUT THE WORLD

London Office: HALIFAX HOUSE
STRAND, W.C.2

PARKSON

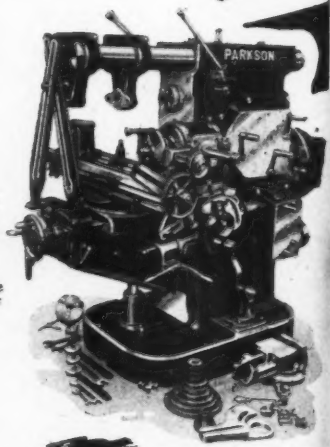
Universal Mills

IN 3 SIZES



1NA

2T



3J

J. PARKINSON
& SON
SHIPLEY YORKS

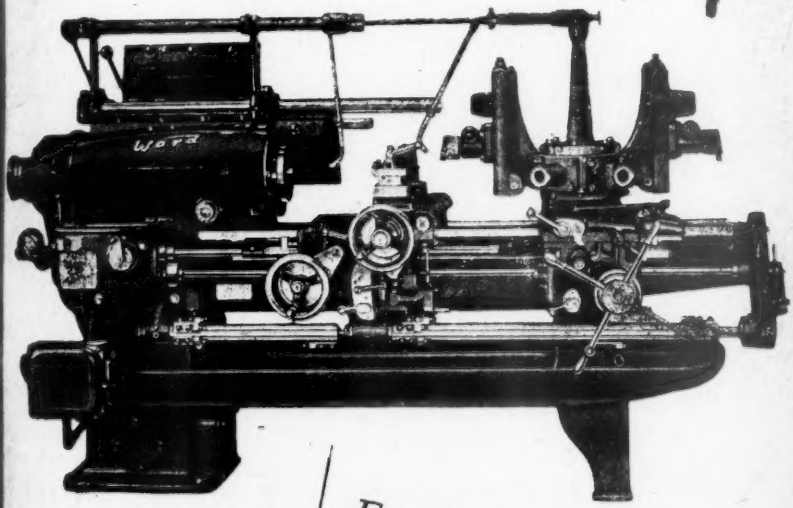
Ward

CAPSTAN AND TURRET LATHES

A WARD No. 7

Combination Turret Lathe with ball and roller bearing headstock but without covers to the bed.

Height of centre	7 in.
Swing over bed	14¾ in.
Swing over top of cross slide	8 in.
Diameter of hole through spindle	2⅛ in.
No. of spindle speeds forward and reverse	8
Spindle speeds	26 to 1000 r.p.m.

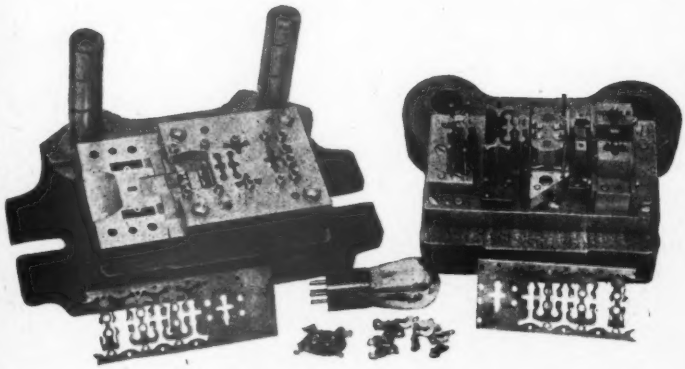


Further Details on Request

H. W. WARD & CO. LTD. *Dale Road Birmingham 29*

PRESS TOOLS

LARGE OR SMALL



We are SPECIALISTS in the DESIGN and MANUFACTURE of SIMPLE, COMPOUND, SUB-PRESS, and FOLLOW-ON TOOLS

ARNOTT & HARRISON LTD.

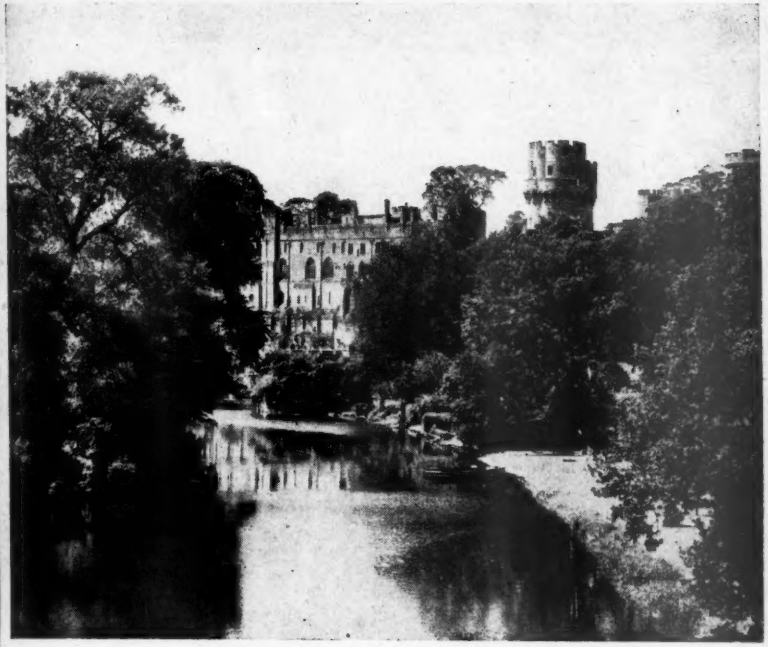
(Member of the Gauge & Tool Makers Association)

22, Hythe Road

WILLESDEN

Telephone: LADbroke 3484-5-6

ARNOTT HARRISON WILLESDEN



In the best TRADITION . . .

. . . the name Churchill has since the year 1865 been in the forefront of machine tool manufacture and distribution, supplying a wide range of the highest quality products.

You should consult the Churchill organisation before deciding your future requirements. Application of their abundant knowledge of machine tools and equipment to your particular problems may mean much to you.

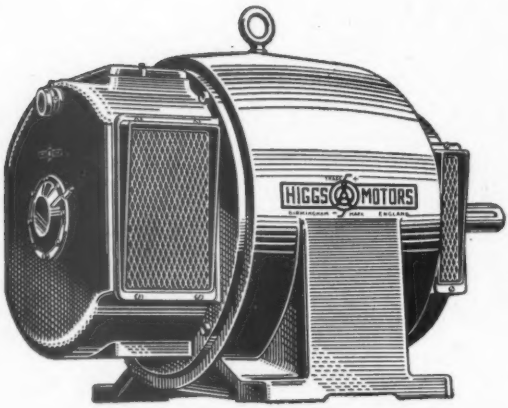
CHURCHILL

Machine Tools & Equipment

CHURCHILL-FAY AUTOMATIC LATHES ■ CHURCHILL GRINDING MACHINES ■ CINCINNATI MILLING MACHINES ■ CINCINNATI GRINDING MACHINES ■ CINCINNATI BROACHING MACHINES CHURCHILL-REDMAN SHAPERS AND LATHES ■ PETERMANN AUTOMATICS ■ CONOMATICS CLEVELAND RIGID HOBBERS ■ JONES & LAMSON TURRET LATHES ■ JONES & LAMSON THREAD GRINDERS ■ NATCO MULTIPLE SPINDLE DRILLING AND BORING MACHINES RED RING GEAR SHAVING AND LAPPING MACHINES ■ RED RING GEAR CHECKING MACHINES

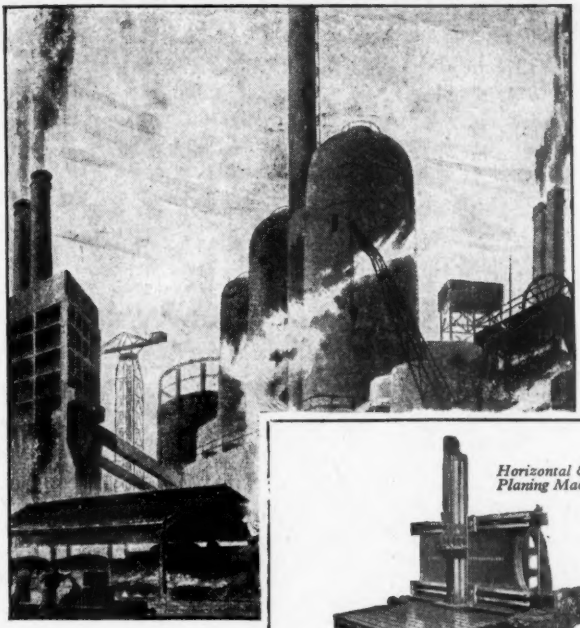
CHARLES CHURCHILL & CO. LTD., COVENTRY ROAD, SOUTH YARDLEY, BIRMINGHAM
CHURCHILL-REDMAN LTD., HALIFAX V. L. CHURCHILL & CO. LTD., WORCESTER

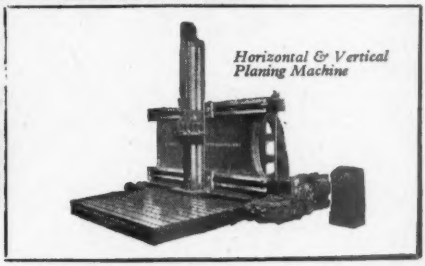
TRADE
HIGGS MOTORS
GOVERNING DIRECTOR WALTER F. HIGGS, M.I.E.E. LTD.
MARK
BIRMINGHAM. 6 ENGLAND



Production for war has extended HIGGS *range of products and broadened our already extensive manufacturing experience. Consequently when the era of competition returns and business is no longer "directed,"* HIGGS *motors will more than ever merit the unfettered choice of discerning buyers.*

BIRMINGHAM, BRISTOL, DUNDEE, GLASGOW, LONDON, MANCHESTER, NOTTINGHAM
PETERBOROUGH, SHEFFIELD





Horizontal & Vertical Planing Machine

OUR PRESENT AIM is maximum production to strengthen the sinews of war.

BUT we are looking forward hopefully to the day when our Machine Tools will be needed to help in making good the devastation wrought by the years of conflict.

WE ARE PLANNING to play our part so well when that time comes that our name will continue to stand for all that is best and most advanced in Machine Tool construction.

ULRB MACHINE TOOLS

Makers of Railway Machinery and Heavy Machine Tools for General Industrial Purposes

FLCB MACHINE TOOLS

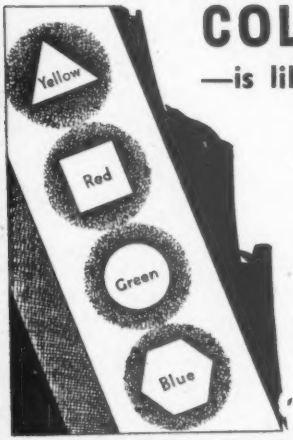
URQUHART LINDSAY & ROBERTSON ORCHAR Ltd
DUNDEE, SCOTLAND

associated with

FAIRBAIRN LAWSON COMBE BARBOUR Ltd
LEEDS

A MACHINE SHOP *without* COLOUR CONTROL

—is like a railway without signals!



Complicated setting by instruction plate wastes time, leads to mistakes. Supervision is equally difficult. With Murray Colour Control correct setting is shown by an unmistakable colour signal of distinctive shape. Setting, the work of a moment, is checked at a glance. The Murray system, standardised by leading tool manufacturers, is making a big contribution to present output. *Full particulars from:*

MURRAY COLOUR CONTROLS LTD.

STANHOPE HOUSE, KEAN ST., LONDON, W.C.2. TEMple Bar 8282

TAS/MK 1.

PRODUCTION MACHINES

FOR

SCREWING
SAWING-OFF
SAW-SHARPENING
TOOL-GRINDING

Subject to Machine Tool Control

VOUCHER LTD.

BRIDGE STREET WALSALL STAFFS.

TELEPHONE 3396

FOR YOUR PROBLEMS in

GEAR SHAPING
TURNING, BROACHING

Our Specialists are always at your service and in the national interest are ready to help you overcome your problems in multi-tooling, gear-shaping or broaching. Why not write us today

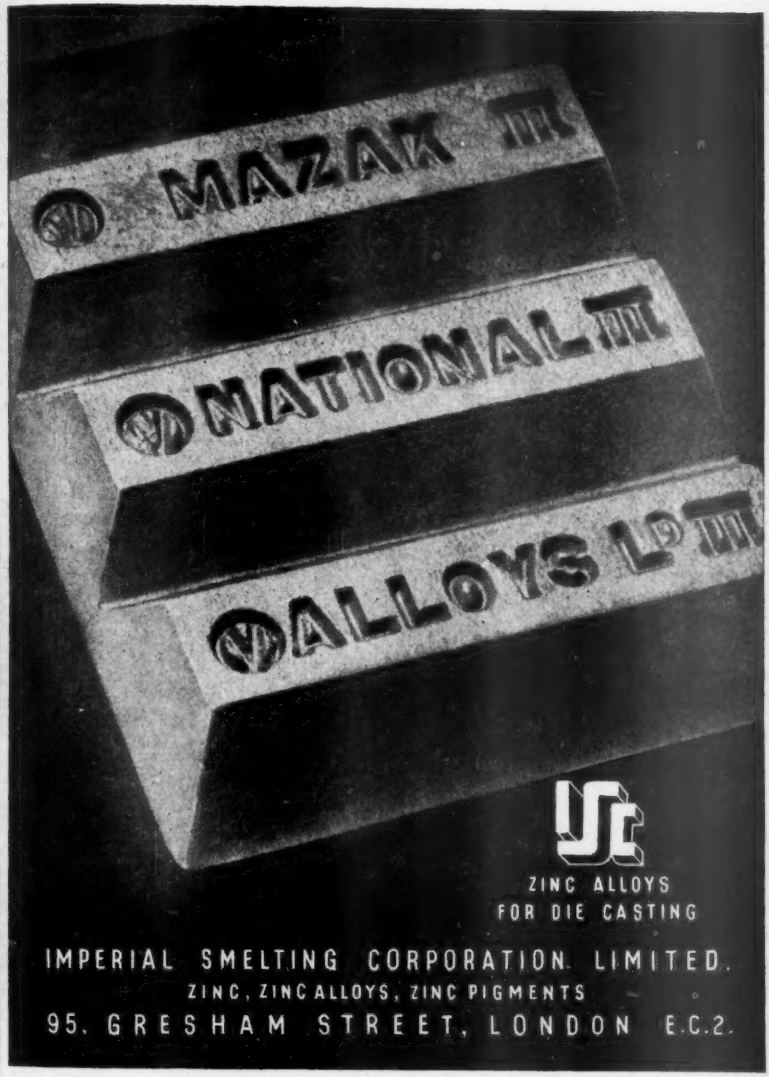
study **DRUMMOND**

MAXICUT MULTI-TOOL LATHES AND GEARSHAPERS • ELECTRAULIC BROACHING MACHINES

consult:

DRUMMOND (SALES) LIMITED
KING EDWARD HOUSE, NEW STREET, BIRMINGHAM

AVO
REG. TRADE MARK.
THE Services and war-time industry are familiar with the high standard of dependable accuracy of "AVO" Electrical Testing Instruments. They will be an equally dominant factor in the post-war rebuilding of our great industries and the advancement of amenities worthy of a world at well-earned peace.
In the belligerent interim, orders can only be accepted which bear a Government Contract Number and Priority Rating.
THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
WINDER HOUSE · DOUGLAS STREET · LONDON · S.W.1
TELEPHONE: VICTORIA 3404


MAZAK
NATIONAL
ALLOYS LTD
ZINC ALLOYS
FOR DIE CASTING
IMPERIAL SMELTING CORPORATION LIMITED.
ZINC, ZINC ALLOYS, ZINC PIGMENTS
95. GRESHAM STREET, LONDON E.C.2.

Assez bon — no bon!!

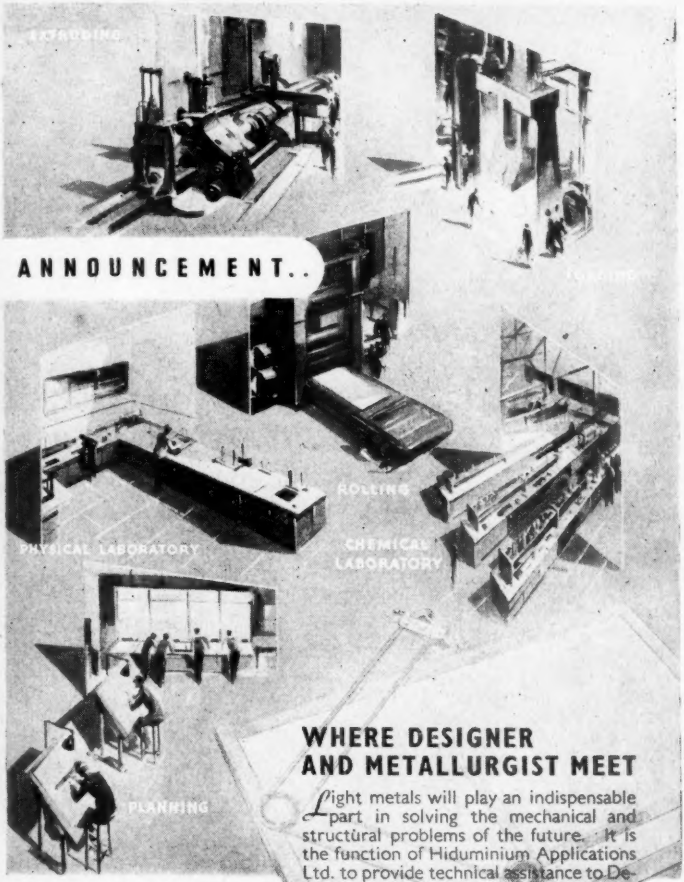
DESOUTTER FAMILY MOTTO
Our kinship with the English is further enhanced by observing that Desoutter, the English manufacturer of portable tools, makes proper use, in his advertising, of such Americanisms as "Pass the buck" and "Give us a big hand." Nothing contributes so much to harmony between nations as a common language.
Extract from that fine American Journal "The Iron Age"

Our jolly old cousins are dashed sportin' but reahlly doncherknow, the compliment is due to them. We don't care whether a phrase or a component or any other bally thing is American or British. We just ask: "Is it the best we can find for the purpose?" That's why we use an occasional American crack in our advertisements — and for that matter an American type chuck in Desoutter Tools. It all fits in with the old Desoutter family motto. Assez Bon — No Bon!! For the benefit of cads on the classical side our Managing Director (who got a certificate for French at Night School) says it is a snappy French way of saying that nothing but the best is good enough for a Desoutter. Jolly old Uncle Sam seems to believe in that motto too for — until we needed the bally things so badly at home — we sold lots of Desoutter Tools in the States. And, Gad Sir, if you can export coal to Newcastle it's got to be dashed good coal, what? Or are we boastin' again?

DESOUTTER Specialists in Lightweight Pneumatic and Electric Portable Tools

DESOUTTER BROS. LTD., DEPT. P, THE HYDE, HENDON, LONDON, N.W.9. Telephone: Colindale 6346-7-8-9

C.R.C. 145



WHERE DESIGNER AND METALLURGIST MEET

Light metals will play an indispensable part in solving the mechanical and structural problems of the future. It is the function of Hiduminium Applications Ltd. to provide technical assistance to Designers and Constructors in all industries who are considering improvements in their products, thus enabling them to utilise fully the outstanding advantages of HIDUMINIUM★ aluminium alloys.

★ *Light weight and high strength · high thermal and electrical conductivity · high resistance to corrosion, workability · ease of fabrication · non-toxic and non-magnetic · excellent appearance.*

HIDUMINIUM APPLICATIONS LTD

ALUMINIUM ALLOYS · FARNHAM ROAD · SLOUGH · BUCKS

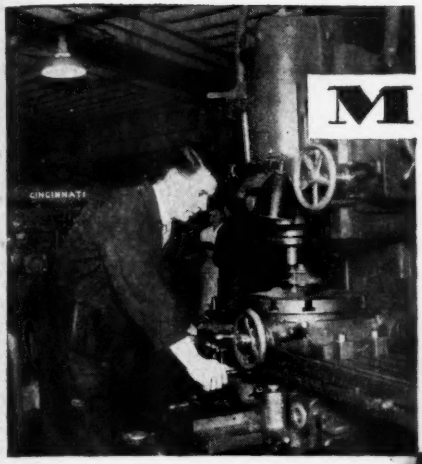
HIGH DUTY ALLOYS LTD · REYNOLDS TUBE Co LTD · REYNOLDS ROLLING MILLS LTD

METAL BONDED DIAMOND TOOLS

This publication contains vital information for engineers engaged on machining and cutting Tungsten Carbide, glass, Quartz and Ceramic materials. Executives will be sent a copy on request.

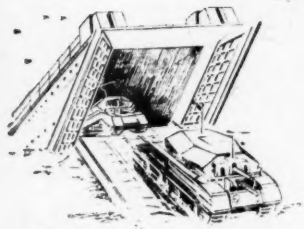
A.C. Wickman LIMITED
COVENTRY · ENGLAND

LONDON BRISTOL BIRMINGHAM MANCHESTER LEEDS GLASGOW NEWCASTLE



MILLING *the* TOOLS

PRODUCTION FOR VICTORY



THAT WILL FINISH THE JOB.. . . .

Specialists in

JIGS & FIXTURES

PRESS TOOLS

AIRCRAFT ASSEMBLY JIGS & REFERENCE GAUGES

CAPSTAN LATHE WORK

HEAT TREATMENT

SMALL ASSEMBLY HAND TOOLS

ILLEY & IO APPROVED

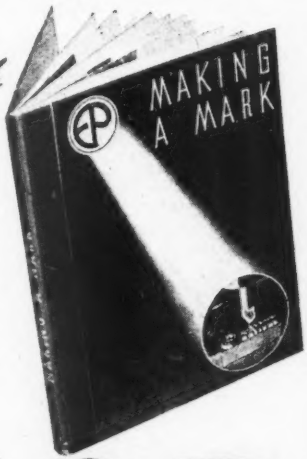
GAUGE & TOOL MAKERS ASSOCIATION

Leytonstone

JIG & TOOL Co. Ltd.

606 HIGH ROAD. LEYTON. LONDON. E.10. PHONE: LEYTONSTONE 5022-3 GRAMS: LEYTOOL, LEYSTON

Now comes the Latest Edition



THE most authoritative work dealing with Marking Methods and Marking Devices. A text book as well as a catalogue.

—o—

76 pages profusely illustrated with 67 plates, illustrations and diagrams

PRICE 5/- NET, POST FREE

PRYOR

EDWARD PRYOR & SON LTD. BROOM ST. SHEFFIELD.

For Gauges, Taps and all Precision Tools. Ensures maximum degree of accuracy after hardening.

NON-SHRINK

PITHO

OIL-HARDENING STEEL

Steel Makers since 1776.

SANDERSON BROTHERS & NEWBOULD LTD SHEFFIELD, ENGLAND.

KING *Electric* CHAIN PULLEY BLOCK

THE KING ELECTRIC CHAIN PULLEY BLOCKS are built for continuous heavy duty. Many are in constant use day and night in large factories throughout the country. Three models available: Minor, Major and Mammoth ranging in capacity from 5 cwt. to 10 tons. Each model is fitted with patent safety limit switches for top and bottom travel. Push button control ensures smooth, efficient easy action.

Write for illustrated booklet on Lifting and Shifting

GEO. W. KING LTD HITCHIN • HERTS
PHONE HITCHIN 960 (10 LINES)

MANCHESTER CENTRAL 3947 | NEWCASTLE 34196 | GLASGOW, DOUGLAS 2798-9

The ideal low-priced machine for tool-room and production

RICHMOND

03 UNIVERSAL MILLING MACHINE

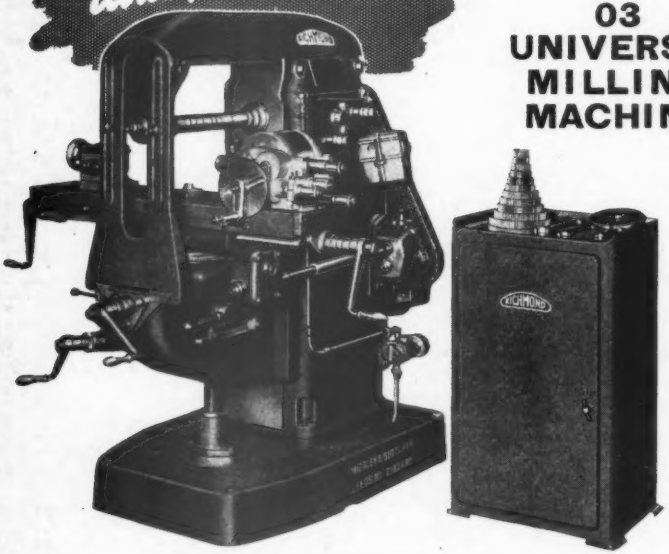


Table Working Surface . 38 in. by 9 in.
Six Spindle Speeds . . . 18–365 r.p.m.
Maximum distance spindle to table 15 in.
Traverses . . . 24 in. by 7½ in. by 14 in.

Send for full details of this and other "Richmond" Milling Machines and Radial Drills

Purchase Certificates must be obtained from the Machine Tool Control before orders for these Machines can be accepted.

Midgley & Sutcliffe

HUNSLET **LEEDS, 10**

Phone : LEEDS 75665

SURFACE GRINDERS

V.9

High Speed VERTICAL SURFACE GRINDER

The Type "V" Surface Grinders are definitely designed for high output on series production. Centralised controls for rapid handling. Table speeds infinitely variable through hydraulic gear with patent vernier control for finishing speeds.

Capacity: 24 in. long by 8 in. wide by 8 in. high.

Write for further particulars of this or larger machines.

SNOW & CO., LTD., SHEFFIELD

LONDON OFFICE: ABBEY HOUSE, WESTMINSTER, S.W.1
BIRMINGHAM HOUSE: DAIMLER HOUSE, PARADISE STREET

MACROME LIMITED, ALCESTER, WARWICKSHIRE

ALSO AT LONDON · GLASGOW · MANCHESTER · LEICESTER · LEEDS · COVENTRY · BRISTOL
BASINGSTOKE · NEWCASTLE-ON-TYNE · BIRMINGHAM

MOTOR GEAR AND ENGINEERING CO. LTD.
ESSEX WORKS · CHADWELL HEATH · ESSEX
PHONE: SEVEN KINGS 3456/7/8/9

AIR OPERATIONS *depend on efficient* PLANT OPERATION

The strain put on production management by the demands of war can only be met by mechanical aids properly applied to plant operation.

The "B. & A. Simplex" production control system provides the most up-to-date and efficient basis for speedy and uninterrupted "take-off" of any number and variety of works orders. It navigates raw material through the shops and lands the finished components safely on the assembly line. In short, it provides the instrument panel and the intercom. system essential to Production Management to-day.

B & A SIMPLEX PRODUCTION CONTROL SYSTEM

At present, B. & A. machines can be supplied only to concerns with high priority orders.

BLOCK & ANDERSON LTD.

OLD MILL HOUSE, TRUMPINGTON ROAD, CAMBRIDGE

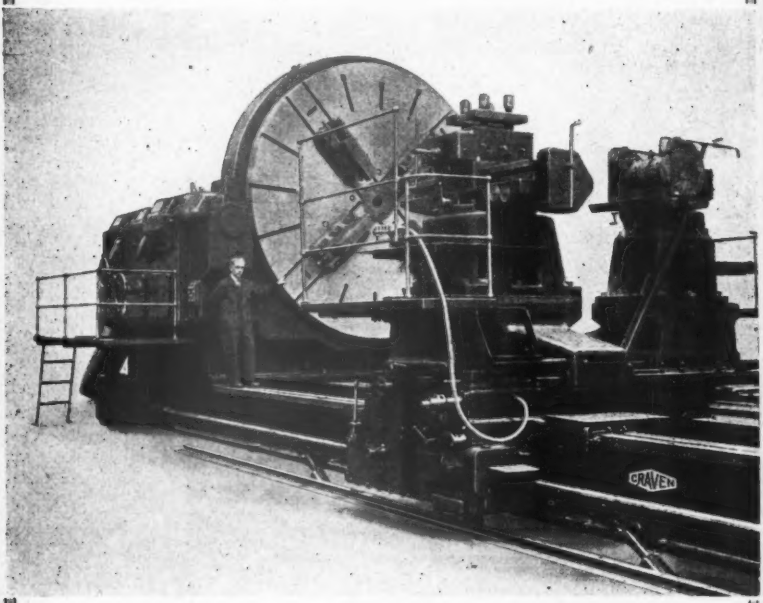
Tel.: Trumpington 305 (3 lines)

Branches at: Birmingham, Manchester, Liverpool, Sheffield, Glasgow, Newcastle, Southampton, Bristol, Nottingham, Cardiff, Belfast and at Victoria House, Southampton Row, London, W.C.1.

PIONEERS OF MECHANISED PRODUCTION CONTROL

CRAVEN

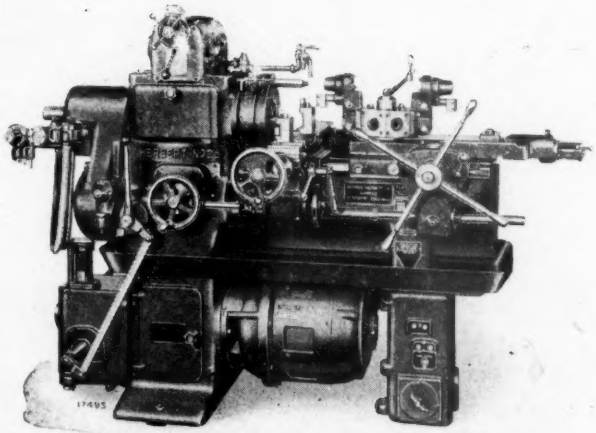
HIGH SPEED LATHES



The illustration shows the driving headstock, left-hand front rest and rear saddle with grinding attachment of a 94 in. centre lathe for machining turbine rotors.
Will swing 13 ft. 1½ in. dia. over saddles
Admits 32 ft. 10 in. between centres
Nett weight 230 tons

CRAVEN BROTHERS (MANCHESTER) **LTD**
REDDISH - STOCKPORT

HERBERT



HERBERT No. 2D CAPSTAN LATHE—MOTOR DRIVEN

Swing Over Bed	**11 in.**	**Working Stroke of Capstan** ...	**6 in.**
Swing Over Cross Slide ...	**5⅝ in.**	**Standard Speed Range** ...	**50-2550 r.p.m.**
Draw-in Chuck Admits ...	**1¼ in.**	**Horse Power of Motor**	**3**

For 200/550 Volts, 3-Phase, 50 Cycles A.C. only

A high speed machine for bar or chuck work.

SPINDLE runs on precision roller bearings.

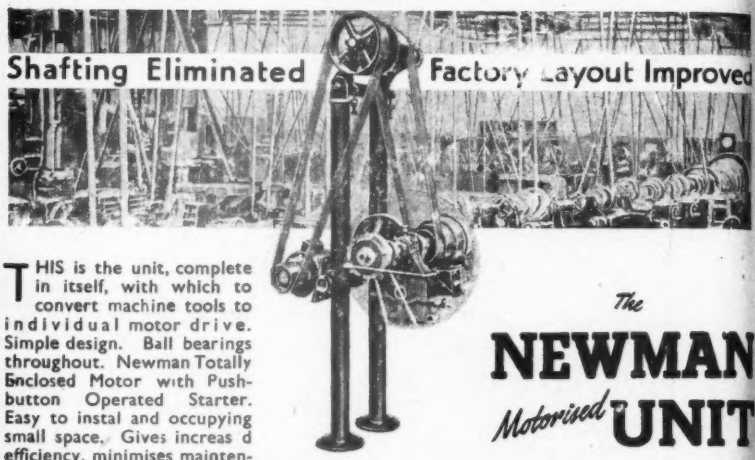
BED and **TOP** and **BOTTOM CAFSTAN SLIDE** are hardened to 478-555 Brinell, this in conjunction with the roller bearing spindle effectively preserves alignment.

SPINDLE SPEEDS. A total of 16 spindle speeds in two ranges of 8. Any speed, forward or reverse, in either range is obtained independently without stopping the spindle.

CAPSTAN SLIDE of improved form. Top slide of unusual width completely covers bottom slide in all positions.

CATALOGUE ON REQUEST

ALFRED HERBERT LTD. COVENTRY



THIS is the unit, complete in itself, with which to convert machine tools to individual motor drive. Simple design. Ball bearings throughout. Newman Totally Enclosed Motor with Push-button Operated Starter. Easy to instal and occupying small space. Gives increas d efficiency, minimises maintenance and reduces costs of production. Quick delivery.

The
NEWMAN
Motorised **UNIT**

NEWMAN INDUSTRIES LTD., YATE, BRISTOL

'PRANA' *PRESSURE*
Die Castings

BASIC METALS
ALUMINIUM. ZINC,
TIN AND LEAD

★ *Write for Treatise on Die Castings*

SPARKLETS LIMITED
(DEPT. ■) LONDON, N18 FOUNDED 1896

A Better Plug Gauge

MECHANICALLY LAPPED TO A HIGH SURFACE FINISH

ON ALL STANDARD SIZES $\frac{1}{4}$" to $2\frac{1}{2}$" DIA.

At No Extra Cost!

A BATTERY OF SPECIAL MACHINES FOR THE MECHANICAL LAPPING OF NEWALL PLUG GAUGES

MECHANICAL LAPPING

Hand lapping has always been recognised as superior to grinding as a finishing operation for plug gauges. Newall, however, have always regarded hand lapping merely as a step in the right direction.

A method of mechanically lapping gauges to an excellent mirror finish has now been perfected and exhaustive tests have shown that the new style of gauge has a much longer accurate life than those finished by other processes.

Mechanically lapped gauges remain accurate approximately four times as long as hand lapped gauges.

The new style gauge is now in full production at no extra cost for standard sizes.

- Super Finish
- Longer Life
- No Extra Cost!

SOLE SELLING AGENTS FOR NEWALL GAUGES

NEWALL

E. H. Jones (MACHINE TOOLS) LTD

Colindale 7011 · EDGWARE RD, THE HYDE, LONDON, N.W.9 · Garantools Telex London

1825

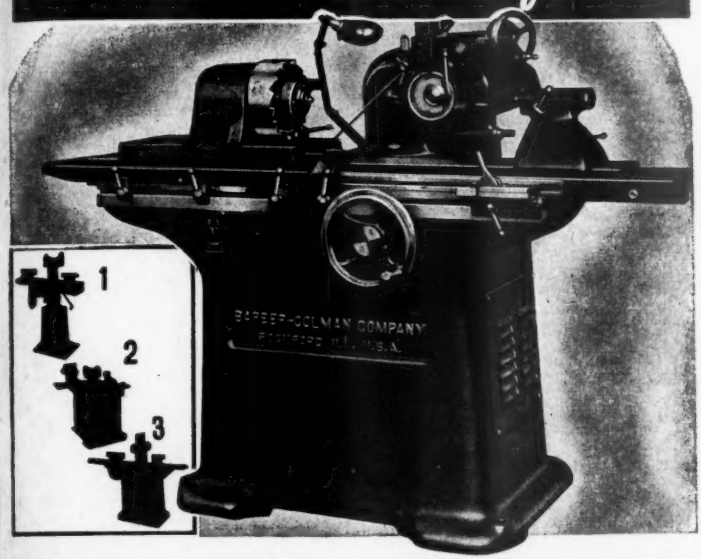
First to prove the existence of a metal in alumina was Hans Christian Oersted, the Danish physicist, when, in 1825, he succeeded in isolating aluminium. Sir Humphry Davy had forecast its existence, but to Oersted belongs the credit of actual production of the metal.

Almost a hundred years were to pass before the widespread use of aluminium demonstrated the value of Oersted's discovery — today we look forward to a world in which aluminium will play an even greater part. The combined technical knowledge of the principal producers of aluminium alloys is at the service of all who seek to use their remarkable properties.

UNION CHAMBERS
63 TEMPLE ROW
BIRMINGHAM 2

WROUGHT LIGHT ALLOYS DEVELOPMENT ASSOCIATION

one machine instead of three



SHARPENS REAMERS, HOBS, AND CUTTERS

With this one machine a wide variety of standard sharpening operations can be performed. In addition, several specialized grinding operations can be handled with greater speed and economy than formerly, yet with no sacrifice of accuracy. Following of spiral leads, indexing, diameter size, blade profile, feed to wheel on tooth face grinding, diameter cutting clearance, relief clearance, wheel dressing, radial faces on high spirals, all these important sharpening factors are under positive mechanical control, and all mechanical movements of the machine can be duplicated to assure uniformity of work on any number of pieces. The machine is equally adaptable for sharpening hobs, all makes of reamers, and milling cutters.

FOR DETAILS WRITE TO

BARBER & COLMAN, LTD., MARSLAND ROAD, BROOKLANDS, MANCHESTER

Telephone SALE 2277 (3 lines) *Telegrams* "BARCOL," SALE.

No order can be accepted without purchase certificate from M.T.C.
Delivery period must be subject to decision of M.T.C.

BARBER-COLMAN *Combination* REAMER
HOB & CUTTER SHARPENING MACHINE

NEWALL JIG BORERS

Made in Three Models

Table Area

Model 0	18" x 12"
Model 1	36" x 24"
Model 2	42" x 24"

Throat Depth

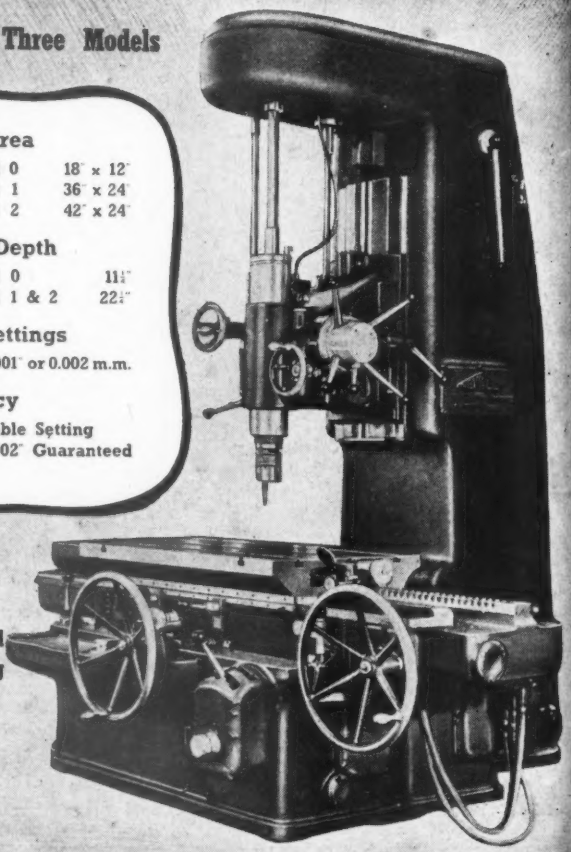
Model 0	11½"
Model 1 & 2	22½"

Table Settings

To 0.0001" or 0.002 m.m.

Accuracy

On Table Setting to 0.0002" Guaranteed



All Three Models Incorporate Newall's Patented Linear Measuring System.

Complete Literature on Request.

NEWALL ENGINEERING CO., LTD.

Phone: PETERBOROUGH 3227-8

PETERBOROUGH • NORTHANTS

Grams: PRECISION Peterborough

Sole Agents: E. H. JONES (Machine Tools) LTD. Edgware Rd., The Hyde, London, N.W.9

INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A *and* B. *Advertisers' announcements only appear in one edition each month, advertisements in edition* A *alternating with those in edition* B *the following month. This Index gives the page number and edition in which the advertisements appear for the current month.*

	Pages
Arnott & Harrison, Ltd.	vi B
Asea Electric, Ltd.	x A
Asquith, Wm. & Co.	iii B
Automatic Coil Winder & Electrical Equipment Co. Ltd., The	xii B
Barber & Colman, Ltd.	xxix B
Baty, J. E. & Co. Ltd.	xxviii A
Block & Anderson, Ltd.	xxiii B
Bratby & Hinchliffe, Ltd.	xvii A
British Aero Components, Ltd.	xxii A
British Die Casting Co. Ltd.	vi A
British Tabulating Machine Co. Ltd., The	xii A
Burton, Griffiths & Co. Ltd.	xvi A ii B
Catmur Machine Tool Co. Ltd.	xv A
Churchill, Chas., & Co. Ltd.	vii B
Climax Rock Drill & Engineering Works, Ltd.	xxv A
Cincinnati Milling Machines Ltd.	xxvii A
Consolidated Pneumatic Tool Co. Ltd.	xxx A
Cooke, Troughton & Simms, Ltd.	xxiv A
Craven Bros. Ltd.	xxiv B
Daniels, T. H. & J., Ltd.	xix A
Dawson Bros. Ltd.	vii A
Dean, Smith & Grace, Ltd.	viii A
Desoutter Bros. Ltd.	xiv B
Drummond (Sales) Ltd.	xi B
Fenner, J. H., & Co., Ltd.	xxiii A
Firth, Thos. & Brown, John, Ltd.	xviii A
Gauge & Tool Makers Association Ltd., The	xx A
Gilman, F. (B.S.T.), Ltd.	xxi A
Guylee, Frank, & Son, Ltd.	xxxi B
Herbert, Alfred, Ltd.	v A xxv B
Higgs Motors, Ltd.	viii B
Hiduminium Applications Ltd.	xv B
Holman Bros. Ltd.	xxxii B
Jessop, William, & Sons, Ltd.	xxxii A
Jones, E. H., Ltd.	xxvii B
King, Geo. W., Ltd.	xix B
Leytonstone Jig & Tool Co. Ltd.	xvii B
Lund, John, Ltd.	ix A
Macrome Ltd.	xxii B
Marshall, Sons & Co. Ltd.	ii A
Midgley & Sutcliffe	xx B
Midland Saw & Tool Co. Ltd., The	iii A
Mollart Engineering Co. Ltd.	xi A
Motor Gear & Engineering Co. Ltd.	xxii B
Murray Colour Controls, Ltd.	x B
National Alloys, Ltd.	xiii B
Newall, A. P., & Co. Ltd.	xxxi A
Newall Engineering Co. Ltd.	xxx B
Newman Industries, Ltd.	xxvi B
Parkinson, J., & Son	iv B
Pryor, Edward, & Son, Ltd.	xviii B
Reavell & Co. Ltd.	xiii A
Sanderson Bros. & Newbould, Ltd.	xviii B
Snow & Co. Ltd.	xxi B
Sparklets Limited	xxvi B
Taylor, Taylor & Hobson, Ltd.	xiv A
Timbrell & Wright Machine Tool & Engineering Co. Ltd.	xxvi A
Urquhart, Lindsay & Robertson (Orchar) Ltd.	ix B
Voucher Ltd.	x B
Ward, H. W., & Co. Ltd.	v B
Wickman, A. C., Ltd.	xxix A xvi B
Woodhouse & Mitchell Ltd.	iv A
Wrought Light Alloys Development Association	xxviii B

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.

The Council of the Institution

1943-44

President

SIR ERNEST J. H. LEMON, O.B.E.

President-Elect

SIR ROBERT MCLEAN

Deputy President

THE RT. HON. LORD SEMPILL, A.F.C.

Chairman of Council

H. A. HARTLEY

Past Presidents

Sir George E. Bailey, C.B.E. — Sir Alfred Herbert, K.B.E.,
The Rt. Hon. Viscount Nuffield, G.B.E. — J. D. Scaife.

Past Vice-Presidents

J. H. Bingham J. T. Kenworthy J. E. Blackshaw R. Kirchner

Vice-Presidents
(Section Presidents)

W. J. Anstey ..... *Coventry*
L. J. Munn ..... *Birmingham*
H. W. Bowen ..... *London*
J. R. Pearson ..... *Luton*
J. W. Davies ..... *Manchester*
I. Garvie ..... *Glasgow*
D. Ransome ..... *E. Counties*
C. W. Mustill, M.B.E. ..... *Yorkshire*
S. R. Howes ..... *Sheffield*
H. B. Dauncey ..... *Western*
F. Blackith ..... *Southern*
M. H. Taylor ..... *Leicester*
L. C. Row ..... *Preston*
J. L. Bennett ..... *Edinburgh*
J. Finlay ..... *Sydney*
C. D. Alder ..... *Cornwall*
C. J. Hyde-Trutch ..... *Nottingham*
W. Scott ..... *N. Eastern*
W. P. Kemp ..... *N. Ireland*
A. Bailey ..... *South Wales and Mon.*
B. S. Round ..... *Melbourne*
E. W. Hancock, M.B.E. *Wolverhampton*
W. P. Eastwood ..... *Halifax*

Additional Section Representatives

F. W. Halliwell ..... *London*
G. H. Hales ..... *London*
J. E. Baty ..... *London*
E. P. Edwards ..... *Birmingham*
J. W. Berry ..... *Birmingham*
H. Spencer-Smith ..... *Manchester*

Ordinary Members

R. M. Buckle, D. Burgess, F. W. Cranmer, J. S. Daniels, W. F. Dormer, H. A. Drane, J. France, T. Fraser, H. J. Gibbons, E. W. Hancock, M.B.E., H. A. Hannay, R. R. Hutchings, E. J. H. Jones, M.B.E., W. C. Puckey, F. A. Pucknell, Dr. H. Schofield, M.B.E., T. Thornycroft, F. C. White, F. Williams, J. G. Young.

General Secretary and Treasurer

K. G. Fenelon, M.A., Ph.D.

Technical Secretary

F. Gibbons, A.M.I.Mech.E., A.M.I.Mar.E.

Section Honorary Secretaries, 1943-4

Birmingham : F. C. White, " Heath House," Wolston, Nr. Coventry.
Cornwall : J. Arthur, " Clifton," Mount Pleasant Road, Camborne.
Coventry : A. W. Buckland, 3, Cawston Way, Bilton, Rugby.
Eastern Counties: D. Braid, Reavell & Co. Ltd., Ranelagh Works, Ipswich.
Edinburgh : J. L. Bennett (Acting), Alder & Mackay, Ltd., New Grange Works, Edinburgh.
Glasgow : W. P. Kirkwood, " Morar," Sandfield Avenue, Milngavie, Dumbartonshire.
Halifax : A. Mitchell, John Stirk & Sons, Ovenden Road, Halifax.
Leicester and District : H. S. Burdett, 18, Stanfell Road, Leicester.
Lincoln Sub-Section : R. Preston, 9, Hunt Lea Avenue, Lincoln.
London : K. G. Fenelon, M.A., Ph.D., 36, Portman Square, London, W.1., Welbeck 2233.
Luton and Bedford : R. M. Buckle, 238, Cutenhoe Road, Luton, Bedfordshire.
Manchester : F. W. Cranmer, Associated British Machine Tool Makers, Ltd., Lloyds Bank Buildings, King Street, Manchester.
Melbourne (Victoria, Aus.) : F. Glover, 41, Moreland Street, Footscray, W.11, Australia.
North Eastern : J. Nicod, A. Reyrolle & Co., Ltd., Hebburn-on-Tyne, Co. Durham.
Northern Ireland : C. C. Bowman, Penshurst, Grand Prix Park, Dundonald, Co. Down, Northern Ireland.
Nottingham : L. Shenton, " The Anchorage," Shaftesbury Avenue, Sandiacre, Notts.
Preston : R. G. Ryder, Thos. Ryder & Sons, Ltd., Bolton, Lancs.
Sheffield : J. P. Clare, St. James' Chambers, 38, Church Street, Sheffield, 1.
Southern : F. Blackith, Wellworthy Piston Rings Co., Ltd., Lymington, Hants.
South Wales and Monmouthshire : J. Vaughan, 131, Penarth Road, Cardiff.
Sydney (New South Wales) : J. M. Steer, 260/262, Kent Street, Sydney.
Western : H. D. Glover, 63, Trelawney Road, Bristol, 6.
Wolverhampton : A. J. Burns, Dudley & Staffordshire Technical College.
Yorkshire : F. Beaumont, 1, Moorcroft Avenue, Oakworth, Keighley, Yorks.

Graduate Section Honorary Secretaries

Birmingham : A. J. Page, 36, Epwell Road, Perry Barr, Birmingham, 22c.
Coventry : R. R. Britain, 65, Holborn Avenue, Holbrooks, Coventry.
London : P. R. Pelly, Feering Croft, Priory Road, Stanmore, Middlx.
Yorkshire : N. Sykes, 389, Killinghall Road, Bradford Moor, Bradford.
Wolverhampton : I. R. Fellows, 9, Pemberton Rd., Coseley, near Bilston.

Student Centre Honorary Secretary

Loughborough College : T. D. Walshaw, B.Sc., Loughborough College, Loughborough, Leics.

INSTITUTION NOTES

August 1944

Extraordinary General Meeting—Official Notice.

NOTICE IS HEREBY GIVEN that an Extraordinary General Meeting of the Institution will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, on Friday, 6th October, 1944, at 11-0 a.m. for the purpose of ratifying the revised Articles of Association circulated herewith.

BY ORDER OF THE COUNCIL.

K. G. FENELON,
General Secretary.

September Meetings.

13th Wolverhampton Section. A meeting will be held at the County Technical College, Wednesbury, at 6-30 p.m., when Mr. A. B. Lloyd will lecture on Production Control.

September Committee Meetings.

8th Meeting of the Co-ordinating Committee at Institution Headquarters, 2-0 p.m.

15th The Finance and General Purposes Committee at Institution Head Office.

18th The Research Department Finance Committee at Loughborough, 10-30 a.m.

26th The Education Committee, Queen's Hotel, Birmingham, at 10-0 a.m.

26th The Membership Committee, Queen's Hotel, Birmingham, 12-30 p.m.

The Technical and Publications Committee meets every Wednesday, at Institution Headquarters, at 5-30 p.m.

Graduateship Examination.

The following candidates were successsful in passing the Graduateship Examination held in May, 1944: A. Bould, R. Charlesworth, G. C. Davey, A. B. Dear, R. C. Dobbs, J. Dunkerley, A. E. Griffiths, A. Humphrey, N. W. Jones, J. J. Mallinson, L. M. Organ, A. F. Pike. J. H. Ray, H. J. Richards, J. Reed, J. Palmer, A. J. Simpson, W. H. E. Smith, D. G. Steel, R. B. Williams, R. C. Wood, W. T. Scarr, S. E. Renew, B. J. Stedman, B. Brock, C. Winstanley, J. C. Rockman, P. Meadows, K. T. Jackson, H. Bradshaw, L. K. Maguire, F. Horsfield.

Contributions to the Research Department.

During the current financial year which commenced on 1st July, the following contributions have been received, and the Council wish to record their grateful thanks to the various companies and individuals who have responded to the appeal recently launched by our President, Sir Ernest Lemon.

	£	s.	d.
Premier Screw & Repetition Co. Ltd.	10	10	0
J. Hobley & Co., Ltd.	5	5	0
Blackburn, Starling & Co., Ltd.	2	2	0
Robey & Co., Ltd.	50	0	0
Herbert Morris, Ltd.	25	0	0
British Manufacturing Research Co., Ltd.	2	2	0
Abbott & Co. (Newark), Ltd.	2	2	0
Crossley Premier Engines, Ltd.	25	0	0
Cylinder Components	10	10	0
Modern Woodworking Machines	2	2	0
W. J. Furse & Co.	5	5	0
Ashwell & Nesbitt, Ltd.	10	10	0
Taylor, Taylor & Hobson, Ltd.	25	0	0
The British Piston Ring Co., Ltd.	10	10	0
Saffro Engineering Co., Ltd.	5	0	0
Manlove, Alliott & Co., Ltd.	31	10	0
Carborundum Co., Ltd.	25	0	0
Clarkes Crank & Forge Co., Ltd.	10	10	0
Rubery Owen Co., Ltd.	21	0	0
Richards (Leicester), Ltd.	10	10	0
G. D. Peters & Co., Ltd.	50	0	0
Paton Calvert & Co., Ltd.	5	5	0
Kitchen & Wade, Ltd.	25	0	0
British Insulated Cables, Ltd.	52	10	0
Commander (E) A. E. Gregg	1	7	0
Fodens, Ltd.	5	0	0
Gimson & Co. (Leicester), Ltd.	10	10	0
Shaw, Sons & Greenhalgh, Ltd.	5	5	0
W. H. Lowe, Esq.		10	6
Total	£444	15	6

In addition to the above the Council gratefully acknowledge the gift of a Comparator from Messrs. Sigma, Ltd., and a set of gauges from Messrs. Denham, Ltd.

INSTITUTION NOTES

August 1944

Extraordinary General Meeting—Official Notice.

NOTICE IS HEREBY GIVEN that an Extraordinary General Meeting of the Institution will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, on Friday, 6th October, 1944, at 11-0 a.m. for the purpose of ratifying the revised Articles of Association circulated herewith.

BY ORDER OF THE COUNCIL.

K. G. FENELON,
General Secretary.

September Meetings.

13th Wolverhampton Section. A meeting will be held at the County Technical College, Wednesbury, at 6-30 p.m., when Mr. A. B. Lloyd will lecture on Production Control.

September Committee Meetings.

8th Meeting of the Co-ordinating Committee at Institution Headquarters, 2-0 p.m.

15th The Finance and General Purposes Committee at Institution Head Office.

18th The Research Department Finance Committee at Loughborough, 10-30 a.m.

26th The Education Committee, Queen's Hotel, Birmingham, at 10-0 a.m.

26th The Membership Committee, Queen's Hotel, Birmingham, 12-30 p.m.

The Technical and Publications Committee meets every Wednesday, at Institution Headquarters, at 5-30 p.m.

Graduateship Examination.

The following candidates were successful in passing the Graduateship Examination held in May, 1944: A. Bould, R. Charlesworth, G. C. Davey, A. B. Dear, R. C. Dobbs, J. Dunkerley, A. E. Griffiths, A. Humphrey, N. W. Jones, J. J. Mallinson, L. M. Organ, A. F. Pike. J. H. Ray, H. J. Richards, J. Reed, J. Palmer, A. J. Simpson, W. H. E. Smith, D. G. Steel, R. B. Williams, R. C. Wood, W. T. Scarr, S. E. Renew, B. J. Stedman, B. Brock, C. Winstanley, J. C. Rockman, P. Meadows, K. T. Jackson, H. Bradshaw, L. K. Maguire, F. Horsfield.

Contributions to the Research Department.

During the current financial year which commenced on 1st July, the following contributions have been received, and the Council wish to record their grateful thanks to the various companies and individuals who have responded to the appeal recently launched by our President, Sir Ernest Lemon.

	£	s.	d.
Premier Screw & Repetition Co. Ltd.	10	10	0
J. Hobley & Co., Ltd.	5	5	0
Blackburn, Starling & Co., Ltd.	2	2	0
Robey & Co., Ltd.	50	0	0
Herbert Morris, Ltd.	25	0	0
British Manufacturing Research Co., Ltd.	2	2	0
Abbott & Co. (Newark), Ltd.	2	2	0
Crossley Premier Engines, Ltd.	25	0	0
Cylinder Components	10	10	0
Modern Woodworking Machines	2	2	0
W. J. Furse & Co.	5	5	0
Ashwell & Nesbitt, Ltd.	10	10	0
Taylor, Taylor & Hobson, Ltd.	25	0	0
The British Piston Ring Co., Ltd.	10	10	0
Saffro Engineering Co., Ltd.	5	0	0
Manlove, Alliott & Co., Ltd.	31	10	0
Carborundum Co., Ltd.	25	0	0
Clarkes Crank & Forge Co., Ltd.	10	10	0
Rubery Owen Co., Ltd.	21	0	0
Richards (Leicester), Ltd.	10	10	0
G. D. Peters & Co., Ltd.	50	0	0
Paton Calvert & Co., Ltd.	5	5	0
Kitchen & Wade, Ltd.	25	0	0
British Insulated Cables, Ltd.	52	10	0
Commander (E) A. E. Gregg	1	7	0
Fodens, Ltd.	5	0	0
Gimson & Co. (Leicester), Ltd.	10	10	0
Shaw, Sons & Greenhalgh, Ltd.	5	5	0
W. H. Lowe, Esq.		10	6
Total	£444	15	6

In addition to the above the Council gratefully acknowledge the gift of a Comparator from Messrs. Sigma, Ltd., and a set of gauges from Messrs. Denham, Ltd.

Higher National Certificate in Production Engineering.

The Joint Committee for Higher National Certificates for England and Wales announce that the following candidates have qualified for Higher National Certificates in Production Engineering: James Abbott, Stanley Armstrong, Douglas J. Billau, Dennis G. B. Bridge, Desmond L. Cohen, George H. Gamble, Peter J. B. Morgan, Arthur Rainbird, Kenneth C. Rooke, Arthur N. Smith, Frederick W. Watson, Norman E. Williams, Norman R. Wright, Dennis G. Wynn.

Personal.

Mr. D. H. MASON, is now Production Manager, Engineering Division, of the De Havilland Engine Co. Ltd.

Mr. T. H. PACKWOOD, has been appointed Process Engineer at Messrs. Tilghman Patent Sand Blast Co. Ltd.

Obituary.

We deeply regret to learn of the deaths of the following members of the Institution:

Mr. Cecil Hadden, Mr. H. S. Locker, Mr. Stephen H. Bailey, Mr. E. D. Rickards.

Book Review.

Calculations from Drawings, by F. Holliday, B.Sc., A.F.R.Ae.S.

Mr. Holliday's book presents trigonometrical solution of triangles in a completely new and true light, dispelling once and forever that awkward question from students "what good is trig."

The subject is shown to be essentially a practical one, rather than pure theory, and should thus arouse interest. The teacher and student of mathematics will be able to relate this subject to practical facts which are shown to have their beginning in the shops.

Those who are uncertain as to what degree of accuracy is required for each mathematical problem are helped by Mr. Holliday's presentation of "real" problems showing in an obvious way how accurate each result needs to be; doubts are dispelled whether the use of 4, 5, 6, 7, figure log tables or simple slide rule are necessary.

Care must be taken to observe carefully the construction lines for each individual problem, as the general tendency would appear to present each problem in such a simplified way that the importance of these vital contructional lines might easily be overlooked by the student.

This practical approach to actual workshop and D.O. problems should assist the student in this branch of production engineering to whom the book is highly recommended.

SOME PRINCIPLES OF PRODUCTION CONTROL AND THEIR APPLICATION TO STEEL FOUNDRY WORK

Paper presented to the Institution, Lincoln Sub-Section, on 31st March, 1944, by A. B. Lloyd

BEFORE plunging into the technicalities involved in the application of a production loading system to manufacturing operations, it is desirable to consider why it is necessary for such systems to be an essential part of almost any up-to-date manufacturing organisation.

Looked at from the accountant's point of view, the production control department is an overhead expense, since the department consists entirely of non-producers. The first question to answer, therefore, is, " It does not produce anything ; why have it? " Broadly speaking, the answer is that in a large and complex manufacturing unit, it is impossible to manufacture the saleable products efficiently without some means of ensuring that the work goes through the manufacturing processes fully in accordance with a pre-conceived plan. By " manufactured efficiently " is meant that the saleable products must be manufactured strictly to specification without waste of labour or material, and must be delivered to time. In view of the large variety of parts which have to be processed, and the number of operations which have to be performed on each article manufactured, and in the assembly of the finished product, the execution of a plan cannot be achieved without the creation of written schedules of work, and written records of what has been done.

Further than this, most executives have probably found when first installing a production loading system run by a specialized department, that unless the production control department, which runs the production loading system, has the authority to insist on the schedules they prepare being met, there is a danger of the production control department becoming a unit which is concerned with the production of paperwork as an end in itself.

It is therefore proposed to devote the first part of the paper to stating the basic conditions which are necessary in the organisation of the works in order that production control may be successfully applied, and lead on to a description of the principles and how they have been applied to facilitate the manufacture of steel castings.

General Principles.

The success, or otherwise, of any scheme depends on sound organisation, which gives the managing director, in charge of a business, effective control of it, combined with active co-operation and consultation between specialist departmental heads, works managers, foremen, and planning engineers. Elaborate schemes of paperwork planning are of little avail if the control of manufacture is loose, and if there is a lack of appreciation of each others functions between personnel of the manufacturing and production control departments.

Fig. 1 shows an organisation chart which could apply to a general engineering concern, employing between one thousand and three

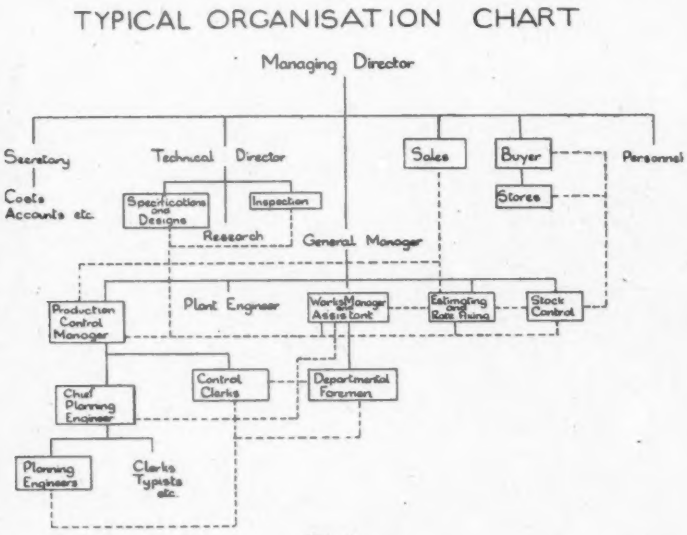


Fig. 1.

thousand people. The chart is intended to bring out the significance of the various functions which have to be taken care of, and shows a typical way in which these functions may be controlled.

The main object of putting on paper an organisation chart, showing how the responsibility of the managing director of a business is exercised through his subordinates, is to ensure (a) that the load of work involved in directing the business is evenly distributed between the executives, and (b) to ensure that each

executive has a clear appreciation of where his responsibilities begin and end. Incidental to these objects is the proviso that each executive must be given responsibilities for which his qualifications and experience fit him. If one is given the task of setting out an organisation chart for a particular business, it is best, in the first instance, to take no consideration of the personalities of existing executives, but to set out functions which have to be taken care of, such as manufacturing, personnel, production control, accounting, etc., and draw them out in such a way as to ensure that no individual executive is responsibile for the activities of more than six subordinates.

Fig. 1 shows an attempt to apply this principle to a typical imaginary engineering concern, and it may be presumed that, in applying this organisation to a particular concern, some amendment would be necessary to take account of the personalities and experience of the executives.

Starting at the top of the chart, we see that reporting direct to the managing director are the secretarial departments, personnel, sales, buying, research, design and development, the three latter being controlled by a technical director or chief engineer. It is not intended to go into the relationship between production control and the accounting and personnel side, although it should be remembered that production control, like every other activity in a business, has its financial implication. We are, however, particularly concerned with the technical departments and the sales and buying departments, since, as will be seen later, these departments are responsible for providing us with basic information which is necessary to enable the production control department to plan effectively, and for co-operating with the production control department in getting out designs, supplying material, etc., to enable production to take place in accordance with the plan.

Also reporting to the managing director is a general manager, who is responsible for manufacture in the broadest sense. He is assisted by a works manager, to whom the foremen of the manufacturing departments report, and who is directly responsible for the effective execution of production requirements. Assisting the general manager are the production control manager, with whom we are chiefly concerned, the plant engineer, responsible for maintenance : the standards, or estimating and rate-fixing departments, responsible for rate-fixing and production times ; and a stock control department, responsible for ensuring that stocks are controlled in accordance with the policy of the management, and that material is available to meet production requirements.

Dealing with the internal organisation of the production control department, this is set up as follows.

The production control manager has control clerks in the works, operating alongside each departmental foreman, and he is assisted by a chief planning engineer, who is responsible for preparing production programmes for each manufacturing department. Thus, in each department, the smooth flow of production depends, to a

BASIS OF FUNCTIONAL CONTROL

PRODUCTIVE AGENT	RESPONSIBLE FUNCTIONAL AUTHORITY
FIXED PLANT	PLANT ENGINEERING DEPARTMENT
LOOSE PLANT. VIZ PATTERN TACKLE, JIGS TOOLS, GAUGES ETC.	METHODS OR JIG AND TOOL DESIGN DEPARTMENT
MATERIAL. RAW OR PROCESSED	STOCK CONTROL
PLANNING. SCHEDULES AND ALLOCATION OF WORK	PRODUCTION CONTROL
LABOUR EMPLOYMENT WELFARE AND TRAINING ETC.	PERSONNEL MANAGEMENT
SUPERVISION. EXECUTION OF PLANS	WORKS MANAGEMENT

Fig. 2

large extent, on the co-operation of three individuals, namely, the foreman of the department, the control clerk, and the planning engineer working from the production control department.

It is now desirable to look at our problem from another angle, and examine various agencies, the effective co-ordination of which is necessary in order to ensure effective production. Our productive agents are: fixed plant; loose plant, such as pattern tackle, jigs, tools, gauges, etc.; material, either raw or processed; plan-

ning, involving programmes, schedules, and allocation of materials; labour, the men who actually do the job with the facilities and material provided; and supervision, represented by the foreman or supervisor who directly controls production. The following departmental heads are responsible for seeing that these productive agents do the work required of them.

FIXED PLANT is the responsibility of the plant engineering department, reporting to the general manager. With the activities of this department we are not concerned in this paper, but, in connection with fixed plant, a word must be said regarding the problem of capacity, since, unless the capacity of fixed plant to produce is known, accurate planning is impossible. For the purpose of this paper, we shall later consider capacity in two senses—(1) *Full capacity*, as the output which can be obtained from the plant under ideal operating conditions, allowing the plant to operate continually day and night, but allowing adequate time for routine maintenance. (2) *Operational capacity*, this being the output of the plant, assuming the normal time for routine maintenance, normal interference with production, and specifying the number of hours during the week which the management considers it desirable for the plant to run.

LOOSE PLANT is a term devised to cover anything required, of a portable nature, for the production of the job, which is not ultimately a component of the finished machine. This definition covers pattern tackle in the case of a foundry; jigs, tools, and gauges in an engineering works. The design of such tackle is the responsibility of a methods or jig and tool design department, operating under the technical director or chief engineer. The production of patterns, jigs and tools is a works function, and the planning of their manufacture is the responsibility of the production control department in the same way as is the production of the goods which are finally sold to the firm's customers.

MATERIAL is the responsibility of a stock controller. In some engineering works a large variety of parts have to be purchased and a number of operations have to be performed upon them before they are finally assembled into a finished machine. In order that the purchasing, storing, and manufacture of these parts may be effectively co-ordinated, a stock control department is set up. In the case of the foundry trade, by far the largest stock value is tied up in raw materials, and there is very little material which has to be stored between manufacturing operations. It is, therefore, the normal practice to put the control of stock in the buyer's hands.

PLANNING is the responsibility of the production control department, and with that we shall be dealing in detail.

LABOUR, which has its problems the same as machinery, is the responsibility of the personnel manager. This subject, again, is not covered by this paper.

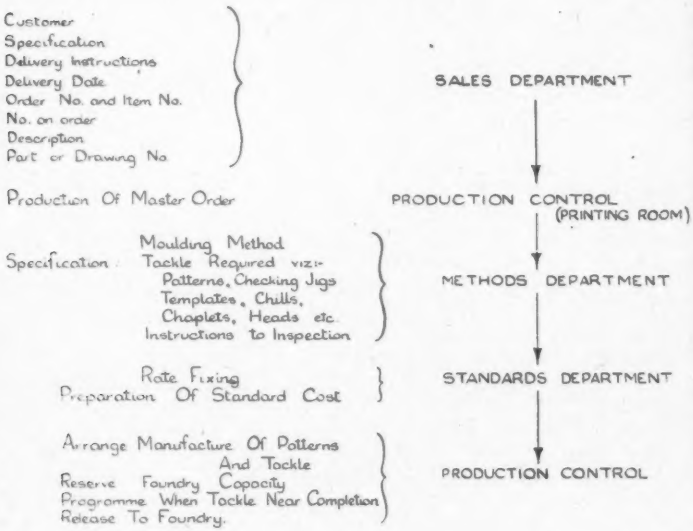
SUPERVISION, which involves the execution of the plan after all other functions have been taken care of, is the responsibility of the works manager.

Application to Manufacture of Steel Castings.

The various functions, whose effective co-ordination contributes to efficient production, have been dealt with, and it will be seen that we gather from them basic information, without which effective planning is impossible.

At this stage, we revert from the general to the particular, and will confine our attention to the application of production control to steel foundry operations. It will be seen that the principles outlined above apply.

PRODUCTION CONTROL ROUTINE
FOUNDRY SET-UP.



PRODUCTION CONTROL DEPARTMENT IS RESPONSIBLE FOR OVERALL PROGRESS FROM RELEASE OF ORDER BY SALES DEPARTMENT TO DESPATCH.

Fig. 3.

Fig. 3 summarises the means used for collecting information required in order to build up a programme of work. Sales department provides the following information :

Customer ; specification, which incorporates the metal in which the castings are to be made, together with particulars of the tests to which they have to be submitted ; delivery instructions and delivery date ; works' order number and item number ; number of castings on the order ; description of the castings ; and part or drawing numbers. All this information is incorporated on an Ormig master order, and is sent to the printing room in the production control department, where all forms necessary to plan, progress and record production of the job are run off. These incorporate foundry order sheets, despatch order sheets, job cards, planning cards, and a variety of other forms.

This information then goes to the methods department who review the job, and decide the way in which it is to be manufactured. This department has to ask itself two questions : (1) How is the job to be made ? (2) What will the works require in order to make it ? Firstly, how is the job to be made ? The moulding method must be specified, that is, whether the job is to be made on a moulding machine, and if so, what type of moulding machine is most suitable for making it. They must specify the type of moulding box that will be required, and any special fettling procedure. Secondly, what will the works require in order to make it ? The standard moulding boxes and equipment available in the foundry will be reviewed, and all the necessary procedure will be set in motion for ordering pattern tackle, jigs, templates, and any other material which is peculiar to the job and not standard equipment in possession of the foundry.

Methods department then passes the job on, after completing its investigation, to standards department, where all the information is translated into production operations and times. Standards department have formulae which enable them to determine the direct time involved in every operation required in the production of the castings, and these times are used as a basis for wage payment. It will be appreciated that considerable consulation is necessary between methods and standards department so as to be certain that the methods adopted are such as will ensure economical production.

The job is then passed back to the chief planning engineer, working in production control department, who, having collected all his basic information, is responsible for planning the manufacture of the job.

In the first place, patterns have to be made. In order to meet the delivery dates, the patterns have to be in the foundry by a certain time. Capacity must, therefore, be reserved in the foundry at a time when the patterns can be ready for production.

Fig. 4 should give a good picture of the preliminary work required before manufacture starts. As the papers are released from the printing room, the revelant forms are sent to methods and standards departments, the remainder of the papers being kept in a clearing box. When the forms return from standards department, duly filled in, they are reviewed by the planning engineer, who reserves capacity in what is termed " dead " load, while patterns, and any other

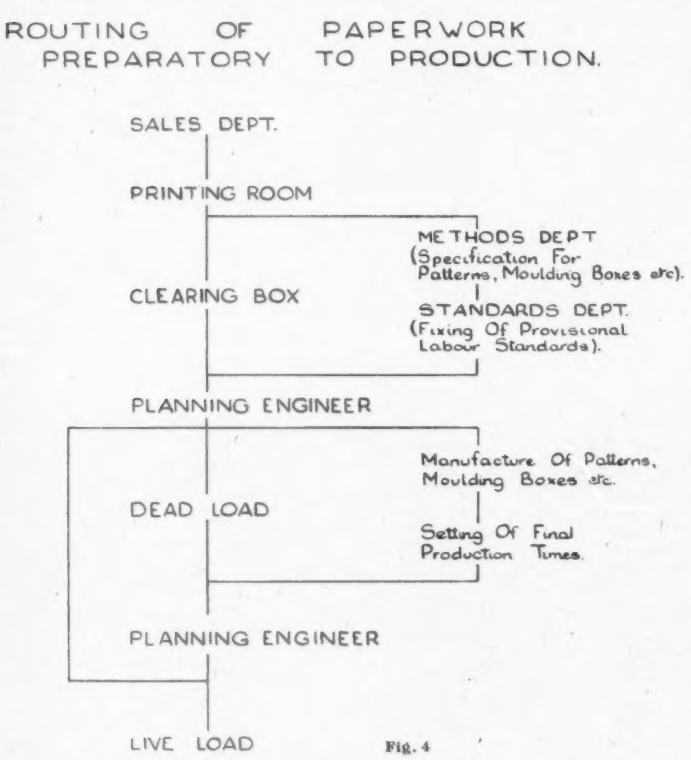


Fig. 4

tackle required, are being manufactured. The term " dead " indicates that, due to patterns not being available, the job cannot be put on the foundry load for production. Upon completion of the patternwork, the planning engineer reviews the job again, puts it on a programme, and so makes up his " live " load.

Now, we come to the kernel of the whole problem, which is the method of planning to be used, now that all the information has been assembled, to enable an orderly scheme of planning to operate.

The production control manager is responsible both for keeping the manufacturing departments supplied with work, and for keeping sales department and the higher management informed regarding how the manufacturing departments are loaded to assist them in forming the sales policy. He uses his load charts to assist him in fulfilling this responsibility.

Let us examine the task which confronts the production control department in making up a programme of work which can be executed by a given date in a department, which, shall we say, has working in it three different types of moulding machines. It must produce a programme of work which will keep each group of moulding machines occupied for a full week, and must be satisfied that it is possible for patterns and cores to be available for feeding the machines. The department must also satisfy itself that the necessary amount of metal, of the right specification, can be made available by the furnaces to ensure that the moulds produced can can be cast. In order that it may carry out this task effectively, it is necessary that the capacity of the core shop for producing cores, the capacity of the moulding machines for turning out moulds, and the capacity of the furnace, serving these machines, for producing metal, is known.

An attempt was made, earlier in this paper, to define the capacity of fixed plant, and it will be recalled that furnaces and moulding machines are fixed plant, within the terms of our definition.

In defining the task set the production control department, we find that we have already used the word " capacity," and in this connection we are referring to what was defined as " operational capacity " of the plant being loaded with work.

More must be said, before going further, regarding the accurate determination of " operational capacity." It may be measured in any suitable units, according to the nature of the work being carried out. The most convenient unit for foundry operations is found to be the allowed hour, this being the quantity of work it is considered a man should be able to execute in one hour, working at a normal rate of effort with reasonable relaxation allowed. The determination of the volume of work which can be obtained from a piece of plant, such as a moulding machine, in a given time, is something which cannot be done accurately without the use of time study, and since the accurate assessment of allowed hours is so vital to us in ensuring that we determine accurately the capacity of our plant, a digression into the field of time study seems, at this stage, to be necessary.

Let us imagine that we are taking a time study on a man making a mould on a moulding machine. The normal practice is to break down the operations he performs, in fulfilling his task, into a number of components. When the time study is worked up, a distinction is made between time spent on operations which were a necessary part of the complete task, time spent on work which could have been been eliminated by more forethought on the part of either the man,

SUMMARY OF DEFINITIONS RELATING TO CAPACITY

NORMAL HOURS	=	Man hours necessary to complete a given task assuming uninterrupted effort and no interference.
STANDARD HOURS	=	Normal hours + allowable relaxation.
ALLOWED HOURS	=	Standard hours + allowance for interference due to shop conditions.
REGULATED HOURS	=	Working hours of shop.
OPERATIONAL CAPACITY	=	(Working hours of shop X number of producers) + expected hours saved

Fig. 5.

the foreman, or the management, and time when the man is not proceeding with the job at all. A summary of the elements of the job which contributed to its successful completion, ignoring entirely time spent in relaxation or incidental work, is called "*normal time.*" Normal time, plus allowances for relaxation, which is necessary to enable the man to maintain his effort throughout the day, is called "*standard time.*" Standard time, plus allowances for incidental

work which the man has to do which could be eliminated by better organisation, is called "*allowed time.*" It is the allowed time which is used as the basis of measurement of our operational capacity. Having obtained from time study the measure of work, we now have to decide, bearing in mind plant conditions, availability of manpower, and load, what shifts need to be worked.

In the works with which the writer is associated, it is the normal practice to post in each department, for each week, what are termed "*regulated hours*" for each group of men in the department, this being the hours that the group of men are called upon to work each day throughout the week. These regulated hours are based very largely on the loading requirements notified to the works manager by the production control department, and form the basis of the operational capacity used by production control department for planning. Allowed hours are set so that a man of average ability may earn between 25 and 50%, saving on the allowed hours issued to him. A full week's work, therefore, for a moulding machine in any one department will consist of a plan which will add up to allowed hours amounting to 50%, in excess of the regulated hours for the man operating the machine, multiplied by the number of operators.

Assuming, therefore, that the production cycle in the department flows smoothly without interruption, capacity for the needs of the core shop and moulding machines can be measured in allowed hours required to turn out the work which will be produced by moulding machines working to operational capacity.

In actual practice, a measure of interference must be expected, and it is usual to issue to the foundry a programme amounting to about 80% of its operational capacity, having available further work which can be put in to fill the gap if the foundry looks like fulfilling the programme ahead of time. This is contrary to the view of some authorities on production control, who maintain that a programme should be issued consisting of at least 100% of the operational capacity of the department. This may be satisfactory in production units manufacturing largely for stock, but it definitely breaks down in steel foundry work, where the foundryman is nearly always manufacturing to a customer's order against short-term requirements. Issuing a plan to a department, which is more than the department can accomplish in the week, means that the uncompleted work has to be replanned, either for the following or subsequent weeks, with the result that a clean start at the beginning of a week is never obtained. Urgent needs are apt to crop up in the middle of a week, and by planning short of capacity, these needs can be accommodated. If no such needs reveal themselves, it is always possible to draw on future plans to make up the week's work. It is the definite experience of the writer that it is very much easier to make work ahead of plan, than, having fallen down on a plan

to interfere with later schedules in order to accommodate the unexecuted work.

Fig. 6 illustrates the information which is given to the foundry department for a machine moulding programme, and in the case of machine moulding, we are able not only to specify that the job is to be done in a particular week, but to lay down a time-table

M/c. Moulding Programme For Mon Day 1·11·1943 Day Shift Week No. C 32

M/c	Time Start	Due Finish	Order No And Item	Description	Box Size	Planned Boxes per Hour	No. of Boxes Planned	No. of Cstgs. Planned	Total Cstgs. Planned to Date	Metal Code	
'P'											
	8.0. a.m.	8.50 a.m.	23879-1	Fork Cstgs. & 1 Test Piece.	20×20×9/9	35	30	30	452	MBT	
	8.50. a.m.	9.15. a.m.	24072-1	Fork Cstgs. & 1 Test Piece	20×20×9/9	35	15	15	5020	MBT	
	9.15. a.m.	11.15. a.m.	24326-2	Clutch Centres	25×18×6/6	42	84	168	1076	H	
	11.15. a.m.	12.35. p.m.	24347-2	Side Cutters	20×16×9/6	41	54	108	432	R	
"	12.35. p.m.	2.50. p.m.	24072-1	Fork Cstgs. & 1 Test Piece	20×20×9/9	35	45	45	5065	MBT	
	2.50 p.m.	5.30. p.m.	23515-1	Track Links	25×18×6/6	26	70	140	4842	L	
'A'	8.0. a.m.	9.30. a.m.	24069-1	A Machine Track Links	30×20×6/6	13	24	48	942	L	
	9.30 a.m.	11.30. a.m.	24878-8	Swing & Prop Gears	25×24×8/6	17	34	34	121	L	
	11.30 a.m.	2.40. p.m.	24069-1	Track Links	30×20×6/6	13	24	48	990	L	
	2.40 p.m.	3.30. p.m.	24878-8	Swing & Prop Gears	25×24×8/6	17	9	9	130	L	

Fig. 6.

of work for each day of operation. The programme therefore comprises the following information : Machine number ; the time of the start and finish of the run off each pattern : the particulars identifying the job, comprising order and item numbers, description, the size of the moulding boxes required, the number of moulding boxes required per hour to meet the plan, the total number of boxes required to complete the castings called for from the pattern, the

number of castings planned, which will be different from the number of boxes if there is more than one casting per mould, and the total number of castings planned on that order. This is for the information of the foundry control clerk. The metal code is also incorporated for the information of the foundry foreman when casting the moulds.

It should be noted that this programme is built up so as to ensure that the machines are loaded up to the number of hours which it

PLANNING CARD

CUSTOMER	THEIR ORDER NO	OUR ORDER NO
ABC Engineering Co.	B 512	61245
	NO. OF ITEMS IN ORDER: 4	DATE OF ORDER: 5-11-43

DELIVERY INSTRUCTIONS: To their 'A' Stores, Queen's Road, Birmingham.

GENERAL INSTRUCTIONS: Pattern to be altered to revised drawing C 817

DELIVERY DATE: 100 sets per week Commencing 1st Dec. 1943

ITEM	NO OFF	TYP	DESCRIPTION	PATT MAKER & TRADE / PATTERN NO	DRAWING NO.	METAL	UNIT WT LBS
3 J FOUNDRY	2000	3H	Rollers	P 423	C 817	M	24

MOULDING PLAN	PATTS PER PLATE	SECTION AND DIA OF MOULD	SAND CORES	PREVIOUSLY PLANNED	REVISED ACTUAL	TO MOULD PLANNED	THIS WEEK ACTUAL	MOULDS UNIT	MOULDS TOTAL	CORES UNIT	CORES TOTAL
M28	2	26×26	3	1100	956	100	120	40	48	18	22

Fig. 7.

has been agreed will provide a working load for the week, at the same time making provision to ensure that no box size is overloaded, that metal is available to meet the plan, and that the core shop has capacity to produce the necessary cores.

We will now look at the planning card, illustrated in Fig. 7, which provides the basic information from which the programmes just referred to are built up, and from which are prepared the load charts which are used to enable reliable delivery information to be given to the sales department.

For every item on every order which comes in, a planning card is produced. This comprises all the basic information prepared

by the sales department, and the following information which is either entered by the planning engineer himself, or collected from the information supplied by the standards and methods departments. Taking a machine moulded job again, the moulding plan week is entered, this being the week in which the job must be produced in the foundry in order to meet the commitment undertaken

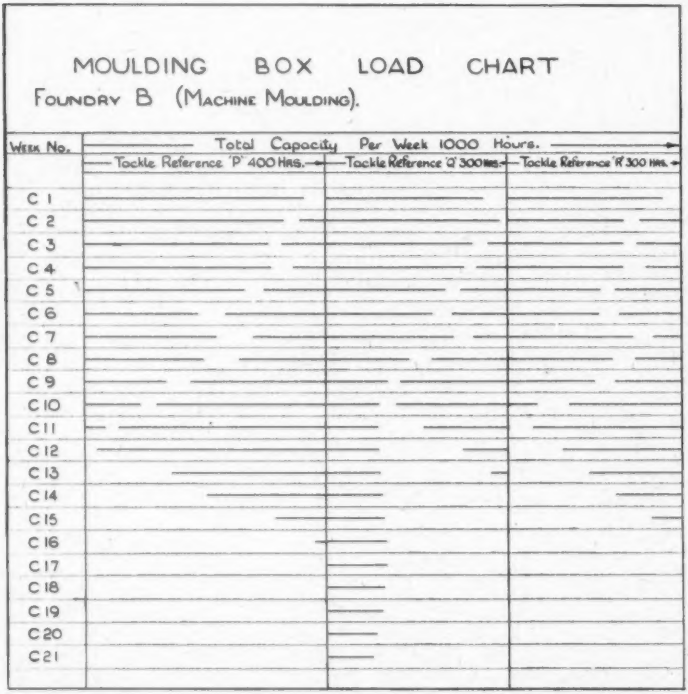


Fig. 8.

to the customer. The number of patterns per plate indicates the number of castings which will be produced per mould from one machine operation. The next column gives the size of box and type of machine on which the job has to be moulded, and also the number of cores on the job. The next column gives the previous history regarding the number of moulds made to date. The next column

gives the number of moulds to be planned for this week, and the last two columns give the number of moulding hours and core-making hours to which this batch refers.

There is one planning card to every item on every order, and further than this, there is one planning card for each week's production off each item. The cards, therefore, for the various items which are planned to be produced on a group of machines in a single week, are filed together.

In the right-hand column on the card, as has been said, are particulars of the moulding hours involved. If these are added up on all the cards for any one week, we can see at a glance how many hours of work we have planned on the group of machines for the current week. These can be transcribed on to the load chart, and on the load chart we can readily see what percentage of capacity the jobs which have been planned fills.

The load chart summarises the information on the planning cards, and a typical load chart is shown in Fig. 8.

You will note that on the load chart shown two distinct lines are indicated for a group of machines, starting from each side of the chart, and not quite meeting in the middle. The lines running from the left-hand side of the chart indicate the total number of hours planned for which patterns and all auxiliary tackle are available for foundry production. Running from the right-hand side of the chart is another line, which is termed the " dead " load. Jobs in the " dead " load are those which are planned for production during a given week, but as the week may be a little way in the future, work has still to be done on the patterns, and the job is still not available for production. A gap between these two lines indicates the capacity available for planning further work. These charts can be kept in pencil, the " live " load line being extended, and the " dead " load line being erased as patternwork is completed on the various jobs. By a moderate amount of capital expenditure, the job can be dealt with more scientifically, and equipment can be provided whereby strips of cardboard can be inserted to represent either " live " or " dead " loads.

Another type of problem comes up in connection with load charts. Sales department may know of work which they can definitely count on booking, but for which they have not yet received firm orders. In these cases, specific reservations can be made for this work, the reservations being taken up as firm orders are received. These requests from sales department may either take the form of a request to reserve a specific number of tons of productive capacity per week in a given section of the foundry, or a customer may send in an approximate schedule of requirements, subsequently covered by firm orders when his exact requirements become known.

by the sales department, and the following information which is either entered by the planning engineer himself, or collected from the information supplied by the standards and methods departments. Taking a machine moulded job again, the moulding plan week is entered, this being the week in which the job must be produced in the foundry in order to meet the commitment undertaken

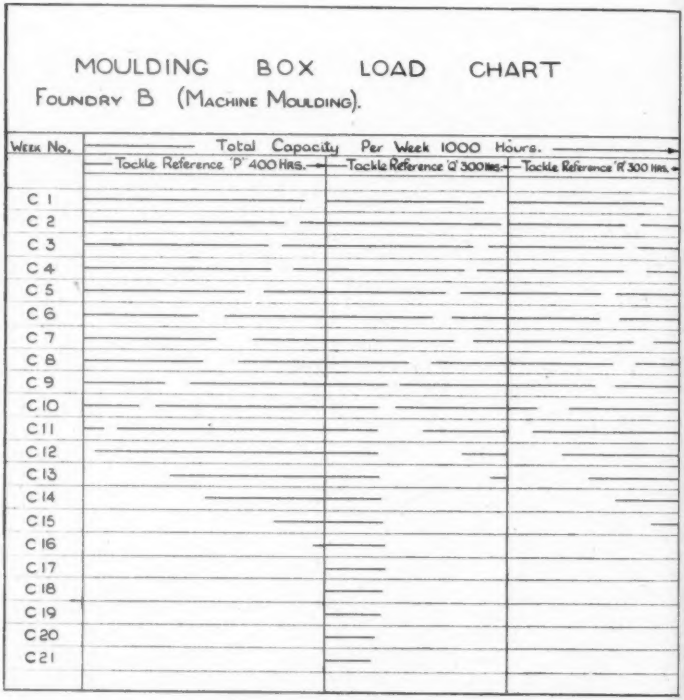


Fig. 8.

to the customer. The number of patterns per plate indicates the number of castings which will be produced per mould from one machine operation. The next column gives the size of box and type of machine on which the job has to be moulded, and also the number of cores on the job. The next column gives the previous history regarding the number of moulds made to date. The next column

gives the number of moulds to be planned for this week, and the last two columns give the number of moulding hours and core-making hours to which this batch refers.

There is one planning card to every item on every order, and further than this, there is one planning card for each week's production off each item. The cards, therefore, for the various items which are planned to be produced on a group of machines in a single week, are filed together.

In the right-hand column on the card, as has been said, are particulars of the moulding hours involved. If these are added up on all the cards for any one week, we can see at a glance how many hours of work we have planned on the group of machines for the current week. These can be transcribed on to the load chart, and on the load chart we can readily see what percentage of capacity the jobs which have been planned fills.

The load chart summarises the information on the planning cards, and a typical load chart is shown in Fig. 8.

You will note that on the load chart shown two distinct lines are indicated for a group of machines, starting from each side of the chart, and not quite meeting in the middle. The lines running from the left-hand side of the chart indicate the total number of hours planned for which patterns and all auxiliary tackle are available for foundry production. Running from the right-hand side of the chart is another line, which is termed the " dead " load. Jobs in the " dead " load are those which are planned for production during a given week, but as the week may be a little way in the future, work has still to be done on the patterns, and the job is still not available for production. A gap between these two lines indicates the capacity available for planning further work. These charts can be kept in pencil, the " live " load line being extended, and the " dead " load line being erased as patternwork is completed on the various jobs. By a moderate amount of capital expenditure, the job can be dealt with more scientifically, and equipment can be provided whereby strips of cardboard can be inserted to represent either " live " or " dead " loads.

Another type of problem comes up in connection with load charts. Sales department may know of work which they can definitely count on booking, but for which they have not yet received firm orders. In these cases, specific reservations can be made for this work, the reservations being taken up as firm orders are received. These requests from sales department may either take the form of a request to reserve a specific number of tons of productive capacity per week in a given section of the foundry, or a customer may send in an approximate schedule of requirements, subsequently covered by firm orders when his exact requirements become known.

We will now deal with the procedure which can be adopted to ensure that accurate delivery information is given when an enquiry is received from the sales department. Looking at our capacity allocation chart, Fig. 9, we see that in total we have a capacity of 1,000 hours per week. We know, however, that customers X, Y, and Z, between them, will call for 700 hours of this, so that we have

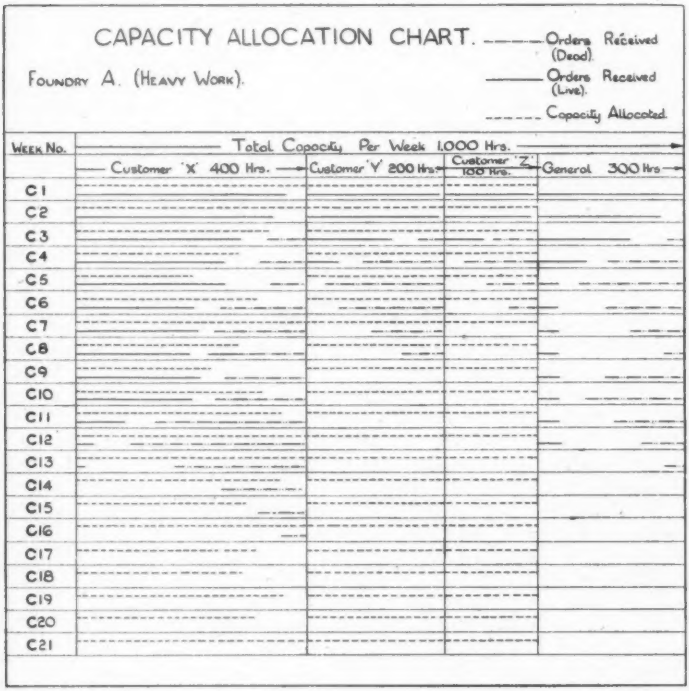


Fig. 9.

only 300 hours available for miscellaneous work. Looking at the chart, we see that the first week in which we have any substantial capacity available is between weeks C.12 and C.13. We therefore send a promise to our customer, based on production commencing at about that date. Sales department may be able to say to us that they definitely expect that order to come in, and ask us to reserve

capacity. In this case, we should put on the chart dotted lines, reserving the necessary capacity at the time.

Generally speaking, however, a jobbing foundry, accepting enquiries for business, does not expect to book orders to the extent of more than 30% of the total number of enquiries it handles. No action is therefore taken to reserve capacity until the firm order is received.

One other point needs to be covered. You will note from previous remarks that a week or so must elapse between the time an order comes through the post to the Company and the time when enough information has been collected to enable it to be put on an allocation chart as a definite load. This difficulty can be overcome by means of an order register. We are able to determine, as soon as an order is received, the weight of the job, and also the foundry department and probable type of machine upon which it has to be made. From each machine or foundry we know that, overall, we get a fairly constant output in terms of moulding hours per ton. We can, therefore, accumulate, each week, the weight of orders received on our order register, and convert this into moulding hours or each tackle reference. The input to the order register consists of the orders received by the sales department. The output from the register consists of jobs planned and incorporated in the capacity allocation charts in accordance with the normal production control routine. The planning engineer, therefore, on receiving an enquiry can look up the tackle reference, see how much work, he has got in his " dead " and " live " loads, see how much work he has in the preparatory stages in his order register, and, by the addition of these three figures, is able to assess very accurately how soon he will be in a position to begin work for which he has received an enquiry.

You will note that the work which has to be done in order to get a job into production has been dealt with in some detail, and also to plan the order in which it is to be produced. Making the mould, however, is only the first operation in the production of a casting. The moulds have to be filled with metal, and knocked out, which is the term defining the separation of the casting from the moulding box and sand. After knocking out, they go to the fettling department, where adhering sand, risers, and heads have to be removed. Finally, the castings have to be annealed, descaled, checked to jigs, and, in the case of heavier castings, marked out to ensure that they are correct to the customer's drawing. A percentage of castings will be scrapped in the various stages of the fettling process. These scraps have to be recorded, and, where necessary, replacements put in hand. Foundry capacity has to be reserved for such replacements, and this is another reason, when making up programmes, for not planning a full week's work at the beginning of the week.

In foundry work, however, once a pattern is in the foundry and the mould made, planned capacity for subsequent operations to be performed, should be available, and the problem of dealing with subsequent stages is more one of progressing than planning.

This paper is, however, more concerned with principles than procedure, and hence its subject matter has dealt more with the organisation and principles connected with planning than actual planning procedure.

Conclusion.

The development of production control as a branch of engineering technique has been forced on the engineering industry on account of the vast amount of detailed information which is required in an organisation of any size in order to meet present-day standards of quality and service, combined with smooth working on a large volume of production. According to the product being manufactured, so the scheme of production control varies considerably in detail, but it does appear that, whatever the product, the same basic principles apply. An attempt has been made to frame this paper on lines which will give the reader some ideas regarding the application of production control to the product on the manufacture of which he is engaged, using for the purpose of illustration, the application of production control to steel foundry work.

Discussion

MR. C. J. HYDE-TRUTCH: I congratulate Mr. Lloyd on a most interesting and valuable paper, and upon compressing what he has done into such a short paper.

I am sure all of us here tonight, who know the results of this valuable system, will join with me in congratulating both Mr. Lloyd and his firm in having established a production loading system which really does work and is producing results. We are receiving 400/500 tons of castings from his foundry every month, and the fact that since this system has been introduced the proportion of deliveries meeting scheduled date has been steadily improving and has reached a very high standard does show that they have got something that really is working. I think possibly one of the secrets behind their success is Mr. Lloyd's point, that any system of loading control must be worked on a realistic basis.

Mr. Lloyd mentioned working to 80% of operational capacity. Those of us who have schemes of this kind may have other percentages, but we all must have some kind of percentage adjustment between planned and actual performance to make our programme

really take account of all the interference that may crop up in practice. Those of us who do not use the same terms as Mr. Lloyd did in his first slides may have had some difficulty in following them, but his explanations made clear any differences. For instance, the definition of a planning engineer used by Mr. Lloyd is one confined to production load planning, whereas it is often taken to refer to one engaged in method or operation planning. In this very full and interesting paper there is a great deal to digest and it is a pity that in wartime it is not possible for advance copies to be published to assist discussion. The meeting is now open for discussion, and Mr. Lloyd will be pleased to reply to any points raised.

MR. JOHNSTONE: I should like to ask Mr. Lloyd a few questions, and I hope he won't think them criticisms, with the hope of obtaining a bit of information in dealing with floor moulding and craftsmen. Can I take it that the number of boxes put down is regular output; if so it is an exceedingly good figure, and to obtain 80% of what you expect is an agreeable achievement. I don't know if the figures were examined at all, or are just figures for filling in your forms. The rate of 35 boxes to the hour, is that an actual figure?

MR. A. LLOYD: It is an actual figure, not from a single machine but from a pair of machines, one working on copes and the other on drags.

MR. JOHNSTONE: What about ratefixing? You in your trade usually take on your price as so much per cwt. Do you fix your prices to the manpower on the job or do you use the more or less criminal procedure of fixing it when half way through? And what about scrap?

MR. A. LLOYD: A large part of our output consists of jobbing moulding on a wide variety of castings weighing between nothing and 20 tons. So far as jobbing work is concerned, for planning purposes we put the moulders in each shop into a single group. Times are predetermined and savings varying from 25% to 100% on basic times are earned. The average savings of the shop as a whole cater for any variations between individual men. All times are determined and made known to the man before he starts his job. Our ratefixers have gone to a lot of trouble in this respect to get accurate basic times. In 1938 we introduced time study throughout our works, with the positive support of the National Union of Foundry Workers. We took a great many time studies on every class of moulding and we were able to establish fairly accurately how much time ought to be spent on each job. Given accurate times, we want the men to earn all they can. Variations in the relative accuracy of the times is inevitable. If they are within 10% however, they may be regarded as sufficiently accurate. As regards scrap,

we do not, at present, penalise the men financially on account of scrap, in view of the difficulty of finding a scheme that works fairly.

MR. V. W. BONE : Mr. Chairman, I should like to make a few comments. I should like to endorse what you yourself said in regard to the paper. I think it is one of the most illuminating papers on this subject. The pleasure of the listeners indicates that Mr. Andrew Lloyd is master of his subject, as I actually know him to be through my contacts with his Company.

I think it is obvious to us that production control is operating in his firm to a very definite extent, and also in other foundries in this country, and I think the credit for having established this is very largely due to our lecturer this evening. (Applause.)

I would suggest that what has been done with regard to the introduction of this very precise control of work, which has hitherto been regarded as capable of being applied in Machine Shops only, has been due to the very great care that was taken at Lloyd's to secure time study, which has made it possible to operate the system we have had described. It has taken a long time to obtain precise knowledge of the times taken and the methods to be followed.

Great credit is due to the management of Lloyd's in securing the agreement of the men to the application of time study to the foundry. A very remarkable achievement when one considers that of all the organised labour foundrymen are the most difficult in regard to any form of payment by results. At the time of the Moulders' Strike in 1923/4 payment by results was one of the main issues, and it was resisted up and down the country for a very long time, and to have persuaded the Moulders' Union of the benefits of payment by results is a very great achievement.

I would like to add my tribute to Mr. Andrew Lloyd for his paper this evening and for the real contribution he has made with his colleagues to the improved efficiency of the Foundry Industry in this country. It is most valuable and he has achieved something which I think will be of lasting benefit.

MR. A. LLOYD : If I may make comment, after what Mr. Bone has said I do not think we can let his remarks pass without mentioning one man without whose tremendous efforts all this would not have been possible. I mean our late Managing Director, Mr. J. Hemming. It was he who was responsible for getting hold of Mr. Chadwick of the National Union of Foundry Workers and it was he who came right out into the open and was able to convince Mr. Chadwick of the necessity of time study. He made an enormous contribution to better understanding between Employers and the Trade Unions.

I feel myself that time study in industry, used in the right way, should, with the backing of both Union and Employers,

do a tremendous amount to improve relations between employers and employed in this country. After all it does mean that in any communication between the two, if there is time study, both sides are negotiating with all the facts on the table. There is bound to be better and closer understanding than can exist when accurate information is not available to either side.

MR. MAPLETHORPE: From Mr. Lloyd's remarks it is noted that there is very carefully planned production up to the Fettling Department, and perhaps Mr. Lloyd would be good enough to explain what happens then?

MR. A. LLOYD: Fettling capacity! That is a problem that is having my very close attention at the moment, and is the subject of considerable debate inside our organisation. I do not feel quite competent to speak with complete experience at the moment. The capacity of the Fettling Department is, or should be, related to the capacity of the Foundry. There is no other method than getting castings put through the Fettling Department in the order in which they are received from the Foundry. It is quite a big problem and the complete solution of it may lend to mechanisation which does not exist in Foundries at present. I think there is enormous scope for further research into mechanisation, and planning of fettling operations. In the Foundry it has always been the biggest headache.

MR. C. J. HYDE-TRUTCH: Would any members who have experience of loading systems in Machine Shops or other departments care to draw comparisons or make suggestions?

MR. A. LLOYD: I would welcome any Machine Shop man's comments. I feel that in the early part of the paper I was trespassing, and I would be pleased to hear any views contrary to those I have expressed.

MR. ——?——: A point of routine. Do you hold the patterns until the castings are through the Fettling Shop?

MR. A. LLOYD: It is our practice to keep them in the Foundry only a day or two after completion of casting. Inspection in the early stages in the Fettling Department should reveal most of the wasters before the pattern has left the foundry.

VISITOR: Your figure of 80. Is that machine moulding with overhead swing feed?

MR. A. LLOYD: Yes.

MR. V. W. BONE: I think it would be of interest if Mr. Lloyd would tell us what steps he took to inform everybody in the organisation in regard to the system. It seems to me a very vital concern. Everybody called upon to function and have a thorough understanding of what it is out to achieve.

MR. A. LLOYD : You have set me a hard task. I think the point was partially covered by the earlier remarks I made on the subject of organisation generally. An organisation chart comes to be published, but unfortunately it is never up-to-date, since an organisation is always developing. The chart given in the lecture shows, from the General Manager downwards, what each executive is responsible for. I mentioned the value of putting this on paper because in the early stages of a scheme of this kind you may get two people at cross purposes, each honestly convinced of the rightness of his point of view. The General Manager should sort out the trouble and give a ruling. If it can be shown according to standing orders, whose job it is to make a particular decision, both men learn as a result of the ruling finally given.

Reference to standing orders can settle an enormous number of difficulties. But there is no substitute for personal tact in dealing with individuals ; only thus is it possible to get all individuals in positions of responsibility working together towards a common objective.

The Production Control Manager, or Works Manager, has got to stimulate and encourage initiative in his subordinates, and must, at the same time, command the respect of every man working for him. He cannot command respect by just asking for it ; he has got to win and earn it. What is equally important he has got to have some respect for people working alongside him. Picture the old type factory foreman who has been there 30 years and always gone his own particular way. Then visualise the Public School and 'Varsity man straight from college, who has taken a course on production loading or personnel administration and comes along to the foundry foreman and tries to dictate to him a proper works plan. Unless they can understand each other, they will soon be at cross purposes. The College man must learn the foreman's point of view and get to appreciate the difficulties of a man changing his ways after 30 years of doing things in a particular way.

MR. V. W. BONE : I had in mind whether the firm had a number of organised lectures. I think the meeting would be interested to know of this, because Mr. Lloyd has certainly used his influence to get everybody together.

MR. A. LLOYD: We try to foster the co-operative spirit. A series of lectures was arranged for all the operating staff, including foremen, production control personnel and members of the other staff departments, and a responsible executive was asked to give a paper about the same length as tonight on the activities of his department and explain why his department was there and what it did. This did a lot to foster the co-operative spirit and encourage co-operation. In an office this afternoon I saw a notice which I

think gives a very good illustration of co-operation—" We are fighting the enemy—not each other."

MR. C. J. HYDE-TRUTCH : I take it these lectures here followed up by meetings of foremen and other executives.

MR. A. LLOYD : There was a discussion after each lecture.

MR. C. J. HYDE-TRUTCH : Don't you recommend regular meetings ?

MR. A. LLOYD : That is an important point. We have regular meetings to discuss urgent problems. A weekly foremens' meeting is very beneficial, as is also a weekly production meeting which is attended by senior executives concerned with production. We go through the position of the various commitments from week to week, and can take decisions at that meeting as to the priority of work in hand. In this way the Works really know the plans before they get them. This is most important. It is vital for the Works Manager to know the importance attached to each of the commitments and have a good idea of the difficulties before the actual plans are given out. Any system of production control is of little value if control of manufacturing operations is loose.

VISITOR : Scrap and late arrival of raw material seriously affect production control. What action is taken to overcome this ?

MR. A. LLOYD: Late arrival of material does not affect a foundry as it affects a Machine Shop, since foundries use primarily raw materials supplied in bulk. Naturally scrap does affect production very seriously and we take measures to minimise it as far as we can by quality control. We minimise the effect on our schedules as far as we can by prompt and accurate reporting of scrap. This brings us to inspection—we carry out 100% inspection on every casting, at the earliest possible stage in fettling. Inspector's Reports are then made out for defectives and replace orders raised These go to the Production Control Office in the foundry, and the replaces are put in hand without delay. The replacement must not however, interfere with the production plan. In the machine moulding foundry the machines are loaded up from 8 a.m. to 5-30 p.m. We have one machine which is used for making short runs and replacements. We have a certain percentage of rejections from our customers, sometimes long after the castings have been made. We make the replacements as quickly as we can, but we try to eliminate this scrap as far as possible by inspection at an early stage.

MR. C. J. HYDE-TRUTCH : As there are no further questions and time is getting on, may I call upon Mr. Lawson to propose a vote of thanks ?

MR. W. S. LAWSON : Mr. President, Gentlemen, we have listened to a most interesting lecture, or rather, talk this evening on a subject which is of great importance to all executives today. We have got to give a lot more study to it in the future than we have done in the past if we are going to hold our own. I should like to congratulate Mr. Lloyd on the distance he has travelled in this most sticky section of the foundry. I only wish I had travelled as far. In the future the loading chart will, I hope, show us not only where we are full but where we are almost unloaded. That is equally important because then we will know exactly what class of work we want if we can get it. Another branch of the foundry industry is trying to progress on the same lines. I mean the non-ferrous. There have been numerous lectures and booklets issued on system control because of its great bearing on ultimate cost.

I have great pleasure in proposing a hearty vote of thanks to Mr. Lloyd. (Applause).

MR. STAIN : Mr. President, Gentlemen, I am sure we are very much indebted to Mr. Lloyd for coming along to give us one of the most interesting lectures we have heard. We are all naturally concerned with the foundry, as of course all delivery promises are based on that. It is very easy in a foundry where you are making just one article and you have the balanced plant. It is in the factory with variety that you most need to forecast the load. In the past we have mostly depended on intuition and you can have good guesses, but there comes a time when these fail, and what we have heard tonight has given us food for thought, and with that I have great pleasure in seconding a vote of thanks to Mr. Lloyd. (Applause).

SPECIAL EQUIPMENT TO FACILITATE THE EFFICIENT USE OF DIAMOND TOOLS

*By Dr. G. Schlesinger and Dr. D. F. Galloway**

In general the most satisfactory setting of diamond tools requires that they be capable of movement about three mutually perpendicular axes. The various effects of rotation about these axes can be seen from Fig. 1. It is clear that rotation about axis XX^1

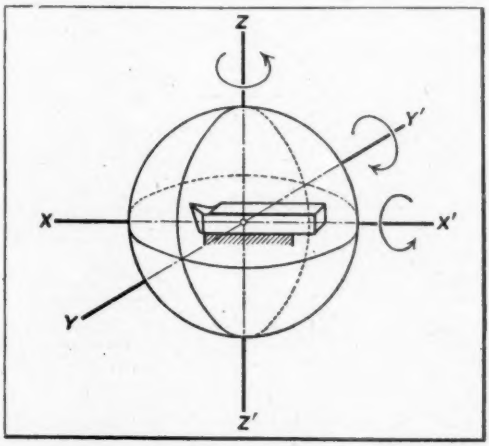


Fig. 1.—Adjustment of tool about three mutually perpendicular axes.

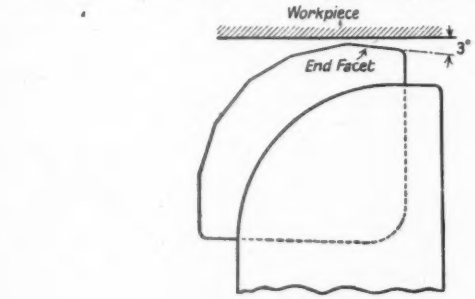
affects side rake and side relief; about axis YY^1, back rake and end relief, and rotation about axis ZZ^1 affects approach angle and plan relief. The main object of the equipment now described is to make possible such movements of turning and boring tools, and to provide means for accurate control and measurement of the movements.

Orientation of Facetted Diamond Tools.

Facetted diamond tools are used extensively for turning and boring non-ferrous components such as light-alloy pistons, brass bushes, babbitted bearings, etc. In many cases it is not only necessary to conform to a high standard of dimensional accuracy,

*This article is based on the results of investigations carried out in the Research Department.

but it is also essential to maintain a very fine surface finish. The surface finish produced in any particular turning or boring operation in which a facetted diamond tool is used is directly dependent upon the inclination of the principal cutting facet of the diamond



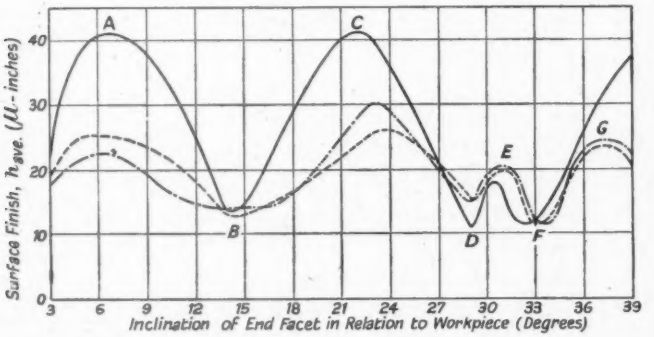


Fig. 2.—Effect of orientation of facetted-diamond tool on surface finish.

tool to the axis of rotation of the workpiece; thus in both turning and boring operations it is desirable to have some means of precise adjustment of the orientation of the tool with respect to the workpiece.

The importance of orientation of facetted diamond tools is well known in practice, but it is nevertheless instructive to observe the results of experiments which show the exact relationship between tool orientation and the surface finish produced. This relationship

can be clearly seen in the graph given in Fig. 2 which represents the results obtained when turning with a facetted diamond tool which was turned to various positions in the horizontal plane so that lengths of specimen were turned with different orientations of the tool.

The angles through which the tool was turned to give the various orientations are shown as abscissæ and the surface finishes obtained

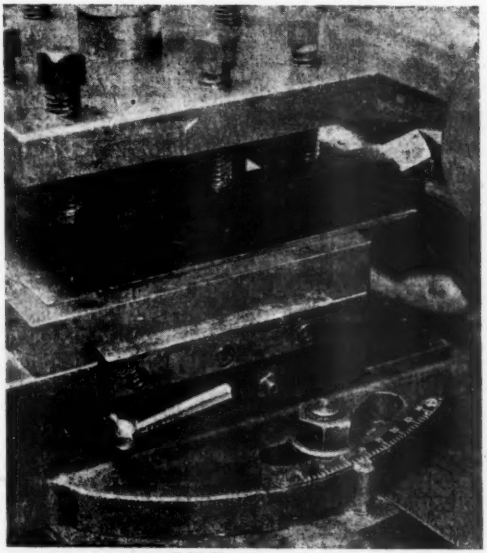


Fig. 3.—Lathe tool post, etc., graduated for orientating the diamond tool

for each orientation are shown as ordinates. The three graphs show results obtained on extruded aluminium alloy using three different feeds, namely, 0.0025-, 0.0015- and 0.0005-inch per revolution. In each case the curves have the same general form indicating the smoothest surface finishes at points B, D, F, where facets were approximately parallel to the axis of rotation of the workpiece, and the roughest surface finishes at points A, C, E, G, which correspond to orientations of the tool where two facets were equally inclined to the axis of rotation of the workpiece.

From these results it is clear that some accurate means of adjusting the orientation of facetted diamond tools with respect to the workpiece being turned or bored is essential if these finishing tools are to be used in the most efficient manner.

In the case of turning operations with facetted diamond tools, it is usually possible to adjust the orientation of the facets with respect to the axis of the workpiece by swivelling the toolpost of the lathe. In well-designed diamond turning lathes, the base of the toolpost is usually graduated, as shown in Fig. 3, so that turning of the tool can be carried out under controlled conditions and fine adjustments of orientation can be made to within $\frac{1}{2}$ or $\frac{1}{4}$ of a degree.

In addition some holders for diamond tips have swivelling heads so that the tool point can be adjusted for orientation while the main shank of the tool remains stationary in the toolpost. In general this method of adjustment is not so sensitive as that obtained by swivelling a graduated toolpost.

In the case of finish boring with diamond tools, provision for adjustment of the orientation of the facets with respect to the workpiece must be made in the boring bar. A special boring bar has recently been developed in the Research Department of the Institution of Production Engineers for this purpose, and is shown in Fig. 4.

The bar is slotted at its end and in the slot a steel block B carrying the diamond tool D is pivotted on two screws S, and adjusted about those pivots by adjusting screws A_1 and A_2. By releasing A_1 and tightening A_2, or *vice versa*, the diamond tool can be caused to rotate about the pivot screws S in the arc C-C, thus altering the

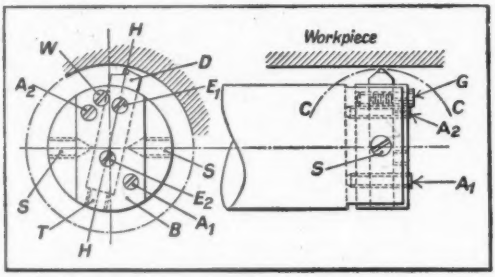


Fig. 4.—Special boring bar with provisions for adjustment of rake and facet orientation.

orientation of the facets on the tool with respect to the axis of rotation of the workpiece. Adjustments of the diamond tool for changes in bore diameter can be made by devices incorporated in some patented diamond boring tools, or by means of a fine screw shown at T in the swivelling steel block B. In either case the diamond boring tool is locked in the block by the locking screws E_1 and E_2.

Adjustment of Rake.

The device also includes a means of adjusting the rake. This is effected by the worm *W* which meshes with teeth on the diamond tool holder and thus rotates the whole diamond boring tool about the axis *H-H*. Graduations of the head of the worm render it possible to control the degree of rotation of the diamond tool and therefore the change in rake. It is clear that any change in rake will be accompanied by an opposite change in clearance since the wedge angle of the diamond remains constant.

Similar provision can be made in the case of diamond turning tools, but usually, as there is more space in this case, it is possible to incorporate larger and more accurate devices for controlling changes in side rake and back rake.

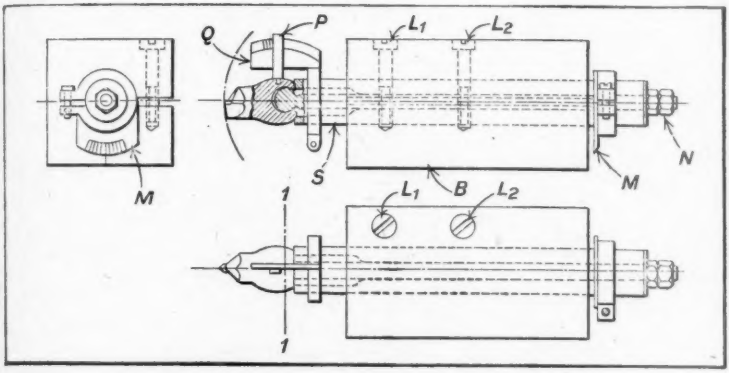


Fig. 5.—Tool holder for variation of side and back rake.

One type of special diamond tool holder which permits easy and controlled adjustment of side and back rake is shown in Fig. 5. A ball-ended tool holder is held by its cylindrical shank *S* in a steel block *B*. The back rake of the tool is adjusted by slackening the lock-nuts *N* and swivelling the point of the tool about its ball pivot so that the pointer *P* moves over the scale *Q* from which it is possible to read accurately the changes in back rake. Adjustment of the side rake is effected by releasing the locking screws L_1 and L_2, turning the shank *S* of the diamond tool and reading on a scale *M* the change in side rake. It will be observed that the introduction of scale *Q* and pointer *P* involves a sideways restriction of ball-pivoted tools. This does not constitute a serious defect because the sideways movement can be effected in a much more

accurately controlled manner by swivelling the whole of the tool slide as already described.

Adjustment of Height of Diamond Tool Relative to the Centre of the Workpiece.

In the case of turning operations the height of the diamond tool relative to the centre of the workpiece can easily be adjusted in the normal way by the use of packing strips.

In the case of boring tools, the setting of tool height relative to the centre of the bored hole is not so easily effected. A special boring bar recently made in the Research Department for investigations on fine boring with diamond tools set above and below centre is shown in Fig. 6. The boring tool T is held in a block B which is free to move in a wide slot cut in the end of the boring bar. Movement of the block is effected by means of the adjusting screw A and is

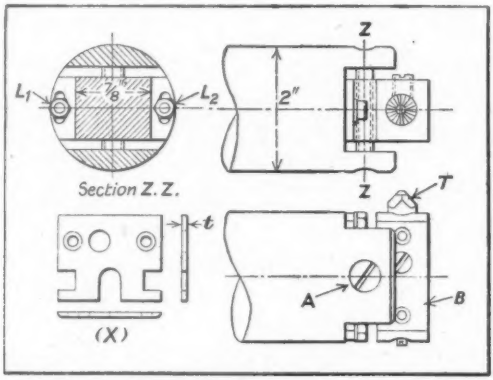


Fig. 6.—Boring bar specially designed to effect adjustment in tool height.

locked in the required position by the screws L_1 and L_2. Movement of the block from its central position disturbs the balance of the boring bar and consequently provision is made to restore this by fixing metal plates of varying thickness t, as shown at X to either side of the block in such a way that the total mass of block plus plates is equally distributed on either side of the centre line of the bar.

The equipment described above was originally developed for experimental purposes, but much of it can, with slight modification, be advantageously applied to commercial diamond turning and boring operations. Research and practice alike have shown that, given good machine design, particularly correct spindle bearing design, and the elimination of vibration, the ultimate fineness of surface finish attainable is largely dependent on the form and setting of the tool used.

THE RESEARCH DEPARTMENT ACTIVITIES

QUARTERLY REVIEW—1

These reviews, which it is the purpose of the Research Department to issue quarterly, are intended to inform members briefly of recent activities of the Department. Some special tests not of general interest and secret investigations carried out for Government Departments will not be included in these Reviews. In general, it is intended that future Reviews shall be shorter than the present one which is to some extent retrospective.

Rough Turning Tests.

The Swift lathe was used for most of these tests which were carried out on mild and alloy steels, cast irons and non-ferrous alloys, using " 18-4-1 " H.S.S., " 66 " and " 46 " substitute steel, Stellite, and cemented carbide tipped tools.

The sizes of cuts used ranged from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. deep and 0.010 in. to 0.080 in. per rev. feed, but the majority of tests were carried out at 0.020 in. at 0.040 in. feed and $^{5}/_{32}$ in. depth, which is approximately 0.5 mm. to 1 mm. feed and 4 mm. depth, and corresponds to Continental and U.S.A. test practice. Cutting speeds were selected to give various lengths of tool life including short tests of 20 min. duration, normal tests of 1 hour's duration, and long tests of 8 hours duration, and full life tests. The speed ranges under various conditions for the ferrous alloys were from 30 to 300 fpm. and in the case of non-ferrous alloys speeds up to 6,000 fpm. were used. The tests included dry tests and wet tests using selected straight and soluble cutting oils.

Special turning tests included form turning of steel, parting of copper, etc.

The main criteria in these tests were tool forces, power consumption, rate and efficiency of stock removal, and tool life. Special equipment has been developed and installed for the measurement of forces and power consumption and in addition special auxiliary equipment, such as an hydraulic Brinell testing machine designed for the measurement of the hardness of large specimens without removing them from the lathe.

Finish Turning Tests.

Very comprehensive scheme of tests covers approximately the same range of materials and tools as for rough turning, but there is a preponderance of non-ferrous alloys and additional tools include facetted and round nosed diamond tools.

Most of the finish turning tests on ferrous materials were conducted with a feed of 0.004 in. and a depth of cut of 0.008 in. which conforms to the I.S.A. standard of 0.1 mm. feed and 0.2 mm. depth for performance finishing tests on lathe tools. In the case of the non-ferrous finish turning, however, the majority of tests were carried out with feeds from 0.0005 in. to 0.0025 in., depths of approximately 0.003 in. and speeds up to 20,000 fpm. In tests to determine the effects of feed and depth upon surface finish, values from 0.00001 in. to 0.005 in. feed and up to 0.100 in. depth were investigated.

The main criteria of tool performance were surface finish produced, surface area turned to a specified surface finish, and tool life. In addition, cutting forces for these fine cuts were measured. In finish turning tests on magnesium alloys one important object was the determination of cutting conditions which reduced risk of fire.

An extensive programme of finish turning tests to determine the effect of orientation of crystallographic axes within diamond tools is being carried out as a joint investigation with the Research Department of The Diamond Trading Company.

A general report on finish turning tests is in preparation and will be published by the Institution in 1944.

Fine Boring Tests.

Wet and dry tests, the criteria of which were surface quality, surface area produced and tool life, were conducted on a range of materials including brasses, bronzes, cast and extruded aluminium alloys and magnesium alloys. Diameters of bore from 1½ in. to 3 in., feeds from 0.0005 in. to 0.005 in., depths up to 0.010 in. and cutting speeds up to 4000 fpm. were used. Diamond and carbide tools were used on standard and special machines with plain and ball bearing spindles. In addition, special tools were used to investigate effect of tool angles, orientation of tip, and tool height relative to centre. Some of this equipment is described in the Institution *Journal*, August 1944.

Comparison of Ball and Plain Bearings.

The tests included standard machines with ball bearings, standard machines with plain bearings and interchangeable plain and ball bearing heads mounted on same machine, thus isolating the effects of different spindles on surface finish.

Drilling Tests.

Two series of drilling tests are being carried out, the first involving the drilling of mild steel, various classes of alloy steel, and various grades of cast iron ; the second included drilling of selected non-ferrous alloys.

In both cases drills of ordinary " 18-4-1 " high speed steel, and substituted " 66 " and " 46 " tool steels are being used.

The tests on the drilling of ferrous alloys are being conducted on a heavy drill testing machine, taking drills up to 3 in., and having a drive of 15 h.p. with a speed range from 30 to 1500 fpm., and 18 feeds up to 21 cuts per inch. The machine used for the non-ferrous drilling tests is a high speed sensitive drilling machine with a speed range up to 6,000 r.p.m. and a 3 h.p. drive. Most of the ferrous drilling tests are being carried out with $\frac{5}{8}$ in. diameter drills, whereas for most of the non-ferrous drilling tests $^3/_{16}$ in. diameter drills are being used.

Less extensive tests are being conducted with other drill sizes ranging from $^3/_{16}$ in. diameter to $1\frac{1}{4}$ in. diameter.

The objects of these tests are to determine the effects of drill form ; i.e., relief, helix angle, length of flute, etc., to observe the influence of various cutting fluids, and to determine the optimum cutting conditions. The main criteria for these tests are thrust, torque, power consumption and drill life. Special equipment has been developed for the measurement of torque and thrust, and for checking drill point form by observations of relief at various radii.

Milling Tests.

Various milling tests have been carried out including slab milling, face milling, gang milling, gear milling, and special tests on non-ferrous facing and non-ferrous sawing operations, for which special cutters were developed. Various grades of straight cutting oils and soluble cutting oils have been used in these tests. Special equipment for a programme of negative rake milling tests is in course of preparation.

A special fabricated slab milling machine has been thoroughly tested in the Research Department for alignment, vibration, and general performance when used for rough and finish milling of ferrous and non-ferrous materials.

Performance of Cutting Oils.

Some effects of cutting oils on drilling, finish grinding, turning, milling and gear cutting operations have been determined. Grinding tests, which include cylindrical grinding of cast irons, mild steels and alloy steels (particularly manganese steel and Ni-Cr.) are in two series ; viz., commercial finish (16-32 mu. in.) with a depth

of cut of 0.001 in. and fine finish (8-16 mu. in.) with a depth of cut of 0.0005 in. Measurement of surface finish and power consumption were among the bases of comparison of the various grades and dilutions tested. Soluble and straight oils used for milling alloy cast steel gear blanks with a 4 D.P., H.S.S. cutter were compared.

Surface Finish.

Tests covered the practical application of surface measurement with the object of relating surface finish, function of part, and method of production. Further details in Report to be published by the Department in due course.

Testing of Machine Tools, Production Equipment, and Instruments.

A number of tests have been made on various types of machine tools such as lathes, shaping machines, milling machines, drilling machines, etc. These investigations have included standard acceptance tests, vibration tests and a wide range of practical tests, and have resulted in many developments which have been adopted by the makers of the machines.

Reports on several of the Researches mentioned above are in preparation and will be published as soon as possible.

D. F. GALLOWAY,
Deputy Director.

30th June, 1944.

Research Department: Production Engineering Abstracts

(Prepared by the Research Department)

NOTE.—*The Addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough. Readers applying for information regarding any abstract should give full particulars printed at the head of that abstract including the name and date of the periodical.*

ACCOUNTING. ADMINISTRATION.

Cost Accountancy; Its Contribution to Management and Efficiency in the Future, by R. Dunkerley. (*The Cost Accountant, March-July, 1944, Vol. 23, No. 3, 6 pp.*).

Retrospect, immediate past and present, the future and uniform costing systems, problems of management, capital control, factory efficiency assessment, marginal costing, budgetary costing, management and labour. Conclusion.

Employment Policy, by T. A. Joynt. (*Labour Management, June-July, 1944, Vol. XXVI, No. 274, 3 pp.*).

Review of the White Paper on employment policy. The transition from war to peace and dangers inherent in the situation. Temporary unemployment. Long-period policy and the maintenance of total expenditure. The stability of prices and wages, and the mobility of labour. The responsibility of industry. Export trade.

COOLANT, LUBRICANTS, FUEL.

Heat Effects in Lubricating Films, by A. C. Hagg. [*Journal of Applied Mechanics (U.S.A.), June, 1944, Vol. 11, No. 2, 5 pp., 7 figs.*].

Heat effects in lubricating films analysed on the basis of simple shear of the lubricant, Reynolds logarithmic formula relating lubricant viscosity and temperature, and an equation relating the heat generation and heat flow in the film. The film-temperature dependence on velocity determined, and the result used to obtain the shearing stress and shearing rates. The formulas thus derived useful in analysing the performance of oil-film bearings. Experiments carried out with measurement of shaft- and bearing-surface temperatures, as well as friction; the tests support the analytical results. An approximate means for judging the importance of film heating in a given case in terms of velocity and lubricant viscosity suggested.

ELECTRICITY, ELECTRICAL ENGINEERING.

Electronic Control Applied to Grinding Machines, by R. A. Cole. [*The Tool Engineer, (U.S.A.), May, 1944, Vol. XIII, No. 5, 2 pp.*].

Adjustable speed possibilities for wheel speed, work speed, infeed, and traverse. Present types of drive units and ideal requirements. Six advantages of electronic control.

Electronic Adjustable Speed Drives, by G. A. Caldwell. [*The Tool Engineer, (U.S.A.), May, 1944, Vol. XIII, No. 5, 3 pp., 3 figs.*].

Principles of ' Mot-o-trol ' system giving speed ranges up to 100 : 1, with good speed regulation under varying load. Important characteristics and operating features ; comparison with : d.c. motor and a motor generator set.

Three Applications of Electronic Drive to Lathes and Milling Machines, by B. T. Anderson. [*The Tool Engineer (U.S.A.), May, 1944, Vol. XIII, No. 5, 3 pp., 5 figs.*].

Lathe application for machining a spiral groove in the end plates of a cartridge reel. Since the load produced by the tool in the cut is light, the total load on the drive is practically constant torque caused by machine friction. For this reason, armature control which is constant torque and has straight line speed response is ideally suited for the forward speed of the machine. The forward speed is controlled automatically from 575 to 1150 r.p.m. In reverse, speed is controlled manually. Standard lathe tooled to turn an internal clearance radius in a propeller barrel, with a rapid approach, feed, and rapid return cycle, a constant horsepower application. Table feed drive on special milling machine to adjust table feed to compensate for rise and fall cycles of head during a contour milling operation.

GEARING.

The Load Carrying Capacity of Gears, by R. Howard. (*Mechanical World, 21st and 28th July, 1944, Vol. 116, Nos. 3003, 3004, 10 pp., 7 figs.*).

Derivation of the relevant load capacity formulae contained in B.S.S. 436, 545 and 721. Wear and strength. Tooth form, material and subsidiary factors. A critical examination of recent technique in manufacture and design. Present-day trends in gear materials. Review of core properties, case depth, bending stress, heat treatment, interpretation of test results, nitriding and induction hardening and surface finish. References.

MACHINE ELEMENTS.

Bearings, by J. Bate. (*Mechanical World, 30th June, 7th July, 1944, Vols. 115* and *116, Nos. 3000, 3001, 4 pp.*).

Part I. Plain bearings. The uses of phosphor bronze. Brass. Cast gun metal. Bronzes made from metallic powders. Precision leaded bronze stick and white metal for bearings. Lubrication and the design of oil lubricating grooves and oil holes. Determination of clearances.

Part. II. Engine bearings. Alignment. Engine bearings and requirements of conformability, embeddability and endurability. Aircraft engine bearings.

The Thicknesses of Bearing Linings in Relation to Specific Requirements, by H. Warburton. (*Mechanical World, 28th July, 1944, Vol. 116, No. 3004, 3 pp.*).

Thin linings more effective than thick if regard be had to a number of important factors. General considerations. Engine bearing temperature, and effect of rate of circulation on cooling. Service conditions of speed and pressure. Tensile stresses in lined bearings and fatigue and distortion effects. Table of bearing data for various services. Table of finished thicknesses of linings for various types of bearings.

Wear-Resisting Materials for Lathe Construction, by R. W. Dayton, C. H. Lorig, and R. E. Adams. (*Machinery-Lloyd, 8th July, 1944, Vol. XVI, No. 14, 4 pp., 4 figs.*).

Four combinations of materials for the wearing surfaces of lathe beds and carriages are in general use : Their manufacturing advantages and disadvantages are thoroughly understood, but the serviceability of each is not, and the study of the problem proved so complex that nearly four years were required to achieve the desired result. Wear is generally due to either abrasive or lack of lubrication. Two types of abrasive cause most lathe-bed wear ; scale from heat-treated steel and dust from cast iron. Tests were done with all combinations of materials for each cause of wear and tabulated results are given and some interesting conclusions are drawn, *e.g.*, that combinations of hardened steel and cast iron were inherently more wear resistant than combinations of cast iron and cast iron and that chilled beds wore faster and scored at lower loads than unchilled beds. Effects of heat treatment and development of "flame-refining." A reciprocating wear testing machine was used for simulated lathe bed service wear tests for long-time abrasive wear tests, and indicated that the combination of a carriage faced with fully-hardened steel strips and a cast iron bed flame-refined to the maximum allowable hardness for scraping will wear far less than any other combination.

MACHINING, MACHINE TOOLS.

Care and Use of Thread-cutting Dies. (*Machinery, 6th July, 1944, Vol. 65, No. 1656, 4 pp., 6 figs.*).

Recommended practice in the maintenance and application of thread-cutting dies having tangential-type chasers.

Automatic Measuring on Grinding Machines. (*Industrial Diamond Review, July, 1944, Vol. 4, No. 44, 6 pp., 10 figs.*).

Three methods are described : (1) measuring by instruments with feelers or test indicators. This section forms the bulk of the article, and describes the principles and construction of various mechanical and mechanical arrangements. (2) Measuring by fixed limit gauges. (3) Measuring by instruments in connection with a grinding wheel to be trued by diamond. An example of this type is described.

Selection and Application of Milling Cutters. (*The Machinist, 1st July, 1944, Vol. 88, No. 12, 12 pp., 30 figs.*).

Methods of classification. Description, use and operation of : profile-type milling cutters, shaped profile cutters, formed milling cutters, and inserted-tooth milling cutters. Tooth angles for different materials. Table of cutting speeds. Permissible feed per tooth. Sharpening practice.

Diesel Engine Cam Milling, by Clifford T. Bower. (*Machine Shop Magazine, July, 1944, Vol. 5, No. 7, 5 pp., 8 figs.*).

Making spare cam shafts for foreign made diesel engines. Diesel engine cams having profiles made up of circular arcs and straight lines machined by means of adaptor plates. Use of a circular table or dividing head to obtain a circular feed motion.

Hyper-Milling. (*Automobile Engineer, June, 1944, Vol. XXXIV, No. 450, 7 pp., 6 figs.*).

American developments in the use of cemented-carbide-tipped cutters. Axial and radial rake angles. Bevel angle. Contour and grinding recom-

mendations. Cutter design factors including cutter diameter. Speeds and feeds. Power required and cutting forces. High degree of surface finish. Practical applications in America in the aircraft industry. Examples of practice at Lockheed and Boeing Cos. Machines and fixtures. Cutter grinding. Operating precautions and methods.

Gear Shaving. (*Automobile Engineer, June, 1944, Vol. XXXIV, No. 450, 4 pp., 3 figs.*).

A discussion of American methods and typical machines dealing with: design of gears to be shaved, previous operations, rack, rotary and curve shaving processes and machines; and gear lapping.

Sheet Metal Pattern Development, by W. Cookson. (*Engineering, 14th July, 1944, Vol. 158, No. 4096, 3 pp., 25 figs.*).

"Roughing-out" methods. Geometrical pattern drafting, in which the specified shape and size of the job, as set out on a working drawing, can be translated into a surface development on the flat metal sheet. Sheet metal design, development, and planning in the drawing office. Detail examples of development.

CHIPLESS MACHINING.

The Pressing of Sheet Metal, by H. W. Swift. (*Sheet Metal Industries, July, 1944, Vol. 20, No. 207, 6 pp., 11 figs.*).

Thickening strains. Blank holders. Deep drawing including multi-stage deep drawing. Punch load required and drawing deep rectangular shells. Forming.

The Design of Stampings for Quantity Production. (*Machinery, 20th July, 1944, Vol. 65, No. 1658, 4 pp., 2 figs.*).

Tolerances. Fits and clearances. Degree of flatness required. Coining and coining dies. Operations supplementary to stamping. Knock-outs. Finishes applied to stampings. Designing for appearance. Drawings and specifications.

Ten Recommendations for the use of Diamond Drawing Dies. (*Industrial Diamond Review, July, 1944, Vol. 4, No. 44, 2 pp.*).

IDR data sheet and "pin up" page No. 5 (new series). (1) Annealing and pre-treatment. (2) Die holder and its treatment. (3) Introduction of wire. (4) Lubrication and cooling. (5) When to withdraw. (6) Spare dies. (7) Drawing speed. (8) Weight of stone. (9) Diamond and sintered carbide dies. (10) Handling diamond dies.

MANUFACTURING METHODS.

Quality Control and the Machine Tool Manufacturer, Parts I and II, by H. Howell. (*The Machinist, 15th, 22nd July, 1944, Vol. 88, Nos. 14 and 15, 3 pp., 2 figs.*).

Quality control. Extent to which its findings can be applied. Data which have a direct bearing on the performance of machine tools. Difference between ideal and everyday machine performance. Suggested makers' guarantees to give values of Standard Deviation for various performances. Suggested tests with form for recording data and certificate.

Hercules Engine Components, by J. A. Oates. (*Aircraft Production, July, 1944, Vol. VI, No. 69, 11 pp., 35 figs.*).

Machining operations on the crankcase, impellor, sleeve, cylinder barrel and connecting rods at a shadow factory.

Assembling Precision Units on a " Stop-and-Go " Conveyor System. (*Production and Engineering Bulletin, July, 1944, Vol. 3, No. 20, 8 pp., 15 figs.*).

Special conveyor supplemented by simple equipment, to facilitate assembly of gyroscope units by previously unskilled labour. Layout plan and method of controlling progress. Operations involved. Control signal and recording gear. Stores. Special tools.

Hawker Typhoon, Part IV, by W. E. Goff. (*Aircraft Production, July, 1944, Vol. VI, No. 69, 7 pp., 17 figs.*).

Organisation and work done on the fuselage assembly track. Installation of power unit, equipment, hydraulic and electric connections is done on an intermittently-moving line operated on a fixed time-cycle. Subsidiary feeder lines arranged alongside the main track bring the sub-assemblies and smaller units into the line at points adjacent to the station at which they are fitted.

MATERIALS, MATERIAL TESTING.

Steel and Its Alloys—The User's Viewpoint, by J. Winning. (*Mechanical World, 30th June, 7th, 14th, 21st July, 1944, Vol. 115, 116, Nos. 3000, 3001, 3002, 3003, 10 pp., 3 figs.*).

Part I. Basic factors. Influence of alloying elements : (*a*) carbon ; (*b*) manganese ; (*c*) silicon ; (*d*) nickel ; (*e*) chromium ; (*f*) molybdenum ; (*g*) vanadium ; (*h*) tungsten ; (*i*) other elements.

Part II. The article goes on to deal with the various types of steel in detail, taking examples as far as possible from the " V " series (BS/STA5). Physical properties and heat treatment are given for carbon, manganese, manganese molybdenum.

Part III. Nickel. Nickel-chromium, chromium.

Part IV. High speed, and substitute high speed steels. Reference table of alloy effects on steel structure.

A General Survey of Steels Used in the Engineering Industry, by C. W. S. Glen. (*Australasian Engineer, 6th April, 1944, Vol. 44, No. 335, 5 pp., 4 figs.*).

Plain carbon steels, alloy tool steels. Alloy constructional steels and stainless and heat resisting steels are briefly, but comprehensively surveyed. Special attention is paid to steels available in Australia from home, U.K., and U.S. mills.

Identifying High Speed Steels by Spark Testing, by L. P. Tarasov. (*Machine Tool Review, May-June, 1944, Vol. 32, No. 191, 2 pp., 1 fig.*).

Necessity for conserving high speed steel, and dangers of mixing different types. Method by which the spark stream of the steel of which the identity is required is compared directly with those of standard specimens. To distinguish steels of the following types : (1) Tungsten 18-4-1 ; 18-4-2 ; 14-4-2. (2) Tungsten-molybdenum (5W, 5Mo). (3) Molybdenum-tungsten (1½W, 9Mo). (4) Molybdenum-tungsten with cobalt (1½W, 9Mo, 5Co).

MANUFACTURING METHODS, APPARATUS.

Gaging Systems, by C. D. Wright. [*The Tool Engineer, (U.S.A.), June, 1944, Vol. XIII, No. 6, 5 pp., 8 figs.*].

Lack of uniformity on gauging policy, in respect to gauge manufacturing tolerances and wear allowances, between American Tentative Standard B4a-1925, Gauge Manufacturers' Association, and B.S.I. The article considers the three systems in detail with particu'ar reference to : (*a*) a definite gauge maker's tolerance, (*b*) a definite wear allowance, (*c*) an intentional difference between work and inspection gauges, (*d*) least encroachment on component tolerance (this embraces direction and magnitude), (*e*) maximum permissible gauge tolerance, (*f*) consideration for small tolerances below .0015 in., (*g*) directon of tolerance—determined by policy, and (*h*) considerations of material and frequency of use bearing on whether work and inspection gauges or inspection gauges only. Suggestions are made for a new (U.S.) national standard.

MECHANICS, MATHEMATICS.

Shrink-Fit Stresses and Deformations, by A. W. Rankin. [*Journal of Applied Mechanics (U.S.A.), June, 1944, Vol. II, No. 2, 9 pp., 16 figs.*].

Expressions derived for the stresses in a solid cylinder of infinite length caused by the action of an applied radial stress distributed uniformly over a single circumferential ring of finite length on the surface of the cylinder. An example of stresses of this type would be a long solid shaft with a uniform pressure applied on the surface for a short axial length. The prac ical worth of the results presented in this paper lie in their approximate applications to shrink fits. Test measurements of shaft deformations due to shrink pressures are included to illustrate the application of the theoretical results.

METALLURGY OF IRON AND STEEL.

A Five Year Plan for an Australian Metallurgical Institute, by R. S. Russell. (*The Australasian Engineer, 8th May, 1944, Vol. 44, No. 336, 5 pp., 2 figs.*).

Proposals for a change in research policy, the setting up of a new public research body, improved co-ordination and better use of existing knowledge, and increased co-operation with other arts and sciences. Summary and references.

PHOTOGRAPHY, FILM X-RAYS.

X-ray Crystal Analysis, by F. Brech. (*Mechanical World, 7th July, 1944, Vol. 116, No. 3001, 4 pp., 5 figs.*).

Identification of chemical composition by powder method. Change of physical properties by back reflection method, including grain size. Lattice distortion produced by cold work, and preferred orientation. Stress measurement. Routine examination of bar material to avoid distortion trouble during machining.

PLASTIC MATERIAL, POWDER METALLURGY.

Surface Fatigue of Plastic Materials, by Earle Buckingham. [*Transactions of the A.S.M.E. (U.S.A.), May, 1944, Vol. 66, No. 4, 14 pp., 18 figs.*].

Progress report No. 16 of the A.S.M.E. special research committee on strength of gear teeth. A special testing machine with which tests have been

run almost continuously during the past six years. Plastic flow of surface lamina and work-hardening. Influence of elastic deformations. Destructive pitting. Summary and discussion. The materials considered are: cast iron alloys, carbon steel, brass and bronzes.

RESEARCH.

Determining Tool Efficiency in High Speed Milling, by W. E. Brainard. (*Mechanical World, July 21st, 1944, Vol. 116, No. 3003, 4 pp., 10 figs.*).

Research to develop a simple and accurate method of comparing and evaluating various designs of high-speed milling cutters by measuring loads directly at the cutter and equating these in terms of material removed. Electrical-type strain gauge used to measure tool load for lathe. Relationships obtained between tool load and speed, feed, depth and rake angles. Instrument developed for use on milling machine.

SMALL TOOLS.

Ground Thread Taps and Thread Rolling Dies, by P. H. Billington. (*Mechanical World, 14th July, 1944, Vol. 116, No. 3002, 3 pp., 7 figs.*).

Modern methods of precision manufacture at Alfred Herbert Ltd. This short article deals with: general manufacture, forming the multi-rib grinding wheels, tap grinding, grinding thread rolling dies, short and long thread milling.

Hob-tooth Profiles for Spline Hobbing, by J. G. Smith. (*Machinery, 13th July, 1944, Vol. 65, No. 1657, 5 pp., 5 figs.*).

Problems involved in the determination of hob-tooth profiles for spline-shafts, sprocket wheels, and similar components. Methods of developing profiles by: (1) graphical and (2) analytical methods. Provision for grinding clearance and chamfers.

Carbides: Something New in Taps, by W. Scotten. [*The Tool Engineer (U.S.A.), May, 1944, Vol. XIII, No. 5, 3 pp., 6 figs.*].

Successful application of a carbide-tipped 90% buttress thread tap used by Wright Aeronautical on radial aircraft engine cylinder heads. Manufacture. Grinding and wheel dressing equipment, with details of technique employed.

SURFACE, SURFACE TREATMENT.

Electroplating: Modern Equipment and Technique, Part VI, by H. Silman. (*Sheet Metal Industries, July, 1944, Vol. 20, No. 207, 10 pp., 8 figs.*).

Metal finishing. Principles involved. Current efficiency, solution composition, and addition agents. Description of plating plant, dealing with tanks, rubber lined plant, and plating barrels; current supply by motor generators and rectifiers, and heating agitation and filtration of solutions.

Electrolytic Methods of Polishing Metals, by S. Wernick. (*Sheet Metal Industries, July, 1944, Vol. 20, No. 207, 6 pp., 5 figs.*).

Part III—Electrolytic polishing of nickel. Bright nickel-plating and its advantages. Types of bright nickel solutions. Difficulties connected with the maintenance of fully bright nickel deposits, and precautions to avoid them. Bright nickel-plating of steel, copper, brass, and zinc.

The Micro-topography of Finely-finished Reflecting Surfaces, by [illegible] Kayser. (*Machinery, 27th July, 1944, Vol. 65, No. 1659, 5 pp., 10 figs.*).

The author describes a method that he has developed for quantitatively determining the micro-topography of finely finished reflecting surfaces on which the maximum depths of the scratches or surface imperfections are of the order of 40 micro-inches or less. Contrary to general opinion, interference fringes from which exact measurements of surface finish can be made may easily be obtained without the use of any special apparatus other than a microscope and a suitable source of illumination. Arrangement of microscope and suitable illuminant for obtaining interference fringes which can be used in exact measurement of surface finish. Suitable light sources. Use in routine inspection. Comparison with results obtained by stylus instruments.

TECHNICAL EDUCATION.

Engineering Education after the War. [*Mechanical Engineering (U.S.A.), June, 1944, Vol. 66, No. 6, 10 pp.*].

A report of a committee of the Society for the Promotion of Engineering Education. (1) Purposes and problems of engineering education. The humanistic-social stem, *i.e.*, methods of organisation, responsibilities of citizenship, and programme and methods of instruction. The scientific-technological stem *i.e.*, emphasis in curriculum organisation. Tools of scientific-technological thought. The art of engineering. Instructional procedures, instruction in the engineering method, discipline in engineering habits of work, cultivation of creative ability, measurement of achievement, recruitment and development of faculties, instruction and research as complementary phases of the work of engineering colleges, and cultivation of the ideals and obligations of the engineering profession. Graduate work and subprofessional technological education and training. Conclusion. (2) Matters of immediate concern. Secondary school preparation for engineering. Selectivity in admission of students. Junior college preparation for engineering. Scholastic ability vs. financial resources. Intensive programmes. Education of veterans and war-industry workers, academic credit for military programmes and rehabilitation of faculties. Conclusion.

TECHNICAL INFORMATION.

Predicting Machine Productivity for Future Applications, by G. B. Carson and L. C. Cole. [*Mechanical Engineering (U.S.A.), June, 1944, Vol. 66, No. 6, 5 pp., 7 figs.*].

Trends in machine design. Necessity for machines which not only have inbuilt accuracy, reliability, and appearance, but also ease of operation and simplification of set-up. Design procedure including (1) conception of the design and check on financial soundness, (2) development of design in the form of plans, layouts, and sketches, (3) development of design in models, and working models of component parts (or the construction of a pilot model), (4) the alternation of designs to facilitate production. The unusual element in the procedure is the inclusion of motion study in the early paper stages of the design. The possibilities and pitfalls of design improvement are shown in a detailed consideration of an automatic screw machine where set-up times were: original machine 60.1 min., first revision 72.1 min., second revision 27.4 min., and final revision 23.1 min.

WELDING, BRAZING, SOLDERING, FLAME CUTTING.

Aluminium Welding on Bombers, by S. H. Brams. (*Machine Shop Magazine, July, 1944, Vol. 5, No. 7, 5 pp., 2 figs.*).

Replacements proposed by Ford Co. to replace riveting by welding on B24 bombers. System of obtaining Army approval. The article deals mainly with resistance welding and covers : clearing cycle, electrode control and quality control of welds.

The Scope, Application, and Development of Welding Processes in Automobile Production, by J. P. Blundell. (*Sheet Metal Industries, July, 1944, Vol. 20, No. 207, 8 pp., 13 figs.*).

Part I. General features of welding. Resistance welding. Fundamental principles. Applications of spot welding. Conditions affecting the weld. Machine construction, control and operation. Portable equipment. Projection welding. Process and its application. Seam welding.

Arc Welding of Magnesium Aircraft Structures, by V. H. Pavlecka and J. K. Northrop. (*Welding, July, 1944, Vol. XII, No. 8, 6 pp., 4 figs.*).

Reasons for the use of magnesium in aircraft. (1) Fabrication methods. (2) Development and characteristics of ' Heliarc.' (3) Helium arc welding. Design considerations. Manufacturing and serviceability problems. Detailed cost comparison with riveting.

Bogie Bracket Support Assemblies, by W. Tindall. (*Welding, July, 1944, Vol. XII, No. 8, 5 pp., 9 figs.*).

Detailed account of cutting, machining, welding and assembly processes utilising fixtures wherever possible.

Brazing, by H. E. Arblaster. (*The Australasian Engineer Science Sheet, 8th May, 1944, Vol. 44, No. 336, 8 pp.*).

A discussion of metal joining processes other than the recognised welding processes, during which a fluid phase is formed. Difference between brazing, bronze welding and soldering. Principles of satisfactory joint formation for the joining alloy, the flux, and assembly prior to joining. Ability of joining metal to wet the parent metal. Bimetallic corrosion. Alloys for brazing and soldering ,including copper ; brazing brasses, silver solders, precious metal solders, joining metals for aluminium alloys and magnesium alloys, semi-soft, soft and substitute solders. Suitable fluxes. Heating media for joining. Strength of brazed and soldered joints. Brazing of tools and tool tips.

WELFARE, SAFETY, ACCIDENTS.

Symposium on Health Hazards of Electric and Oxy-Acetylene Welding, by R. Gardner. (*Australasian Engineer, 6th April, 1944, Vol. 44, No. 335, 4 pp., 3 figs.*).

Notes from a meeting of the New Zealand Institute of Welding held at Dunedin, July, 1943. Dangers of electric shock, oxides of nitrogen, carbon dioxide and carbon monoxide, metallic fumes and organic vapours, radiant energy. Treatment and precautions. Lead poisoning and " zinc chills."

WORKS AND PLANT.

The Welding Manipulator, by I. R. Waller. (*Welding, July, 1944, Vol. XII, No. 8, 5 pp., 5 figs.*).

Uses and advantages of modern handling equipment. Types of manipulator available for different classes and sizes of work, up to 15 tons in weight. Procedure. Comparison of output.

WOODWORKING.

Wooden Spar Production, by Ronald Grierson. (*Aircraft Production, July, 1944, Vol. VI, No. 69, 8 pp., 8 figs.*).

An electro-thermal method of reducing the setting time required for urea-formaldehyde resins. This article traces the design of a type of electrically-heated panel, for the production of de Havilland Mosquito spars. This equipment is of particular interest as representing a successful application of surface-heating principles, after careful preliminary survey, to special requirements. Design principles and figures are given in detail.

SEP 81

THE INSTITUTION OF PRODUCTION ENGINEERS

Articles of Association

Extraordinary General Meeting—Official Notice.

NOTICE IS HEREBY GIVEN that an Extraordinary General Meeting of the Institution will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, on Friday, 6th October, 1944, at 11-0 a.m. for the purpose of ratifying the revised Articles of Association circulated herewith.

BY ORDER OF THE COUNCIL.

K. G. FENELON,
General Secretary.

Revised and passed by Council, 23rd June, 1944, and to be submitted for confirmation to an Extraordinary General Meeting of members to be held on October 6th, 1944, at the Institution of Civil Engineers, Great George Street, Westminster, at 11-00 a.m.

PRELIMINARY.

1. In these articles :—

"The Act" means the Companies Act, 1929.

When any provision of the Act is referred to the reference is to such provision as modified by any statute for the time being in force.

Unless the context otherwise requires, expressions defined in the Act or any statutory modification thereof in force at the date at which these articles become binding on the Institution, shall have the meanings so defined.

2. For the purpose of registration the number of members of the Institution is declared not to exceed 1,000, but the Council may at any time register an increase in the number of members.

3. These articles shall be construed with reference to the provisions of the Act.

4. The Institution is established for the purposes expressed in the Memorandum of Association.

MEMBERSHIP.

5. The Institution of Production Engineers (hereinafter called "the Institution") shall consist of Honorary Members, Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates, and Students. The use of the words "members" and "membership" in these Articles shall include all the foregoing.

6. No Honorary Member, Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student shall, by reason of being legally a member of the Institution, be entitled to any privileges other than those which by these articles attach to the specific class of member of the Institution to which he belongs, and wherever the term "Member" is hereinafter used without qualification, it shall be taken to mean Member, and shall exclude Honorary Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates, and Students.

7. The Subscribers to the Memorandum and Articles of Association shall be the first Members of the Institution. The Council may admit such other persons as may be hereafter qualified and elected by the Council in that behalf as Honorary Members, Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates and Students, respectively, but such persons shall sign such form of application or consent as may from time to time be authorised by the Council.

8. The rights and privileges of every Honorary Member, Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, and Student shall be personal to himself, and shall not be transferable or transmissible by his own act or by operation of law.

ABBREVIATED TITLES.

9. The abbreviated distinctive titles to indicate the connection with the Institution of the various grades of membership shall be as follows:—For an Honorary Member, Hon.M.I.P.E.; for a Member, M.I.P.E.; for an Associate Member, A.M.I.P.E.; for an Intermediate Associate Member, Int.A.M.I.P.E.; for an Associate, A.I.P.E.; for a Graduate, Grad.I.P.E.; for a Student, Stud.I.P.E.

Such abbreviations shall not be used by any members who have resigned or been removed from the Institution, nor may they at any time be used upon any shop front, facia, or sign. If used upon door or wall plates or similar places, the abbreviations shall not exceed 1½ in. in height.

CERTIFICATES.

10. Subject to such regulations as the Council may from time to time prescribe, the Council will on receipt of an application, issue

to any Member, Associate Member, Intermediate Associate Member, or Associate, a Certificate showing the grade to which he belongs. Every such certificate shall be according to the form which may from time to time be approved by the Council, and shall remain the property of, and shall on demand be returned to, the Institution.

QUALIFICATIONS FOR MEMBERSHIP.

Honorary Members.

11. The Council shall have the power to elect as Honorary Members, those who by reason of their special services to the Institution or production engineering generally, are entitled to such recognition.

Members.

12. Candidates for admission to the grade of Member, must be persons not under thirty-three years of age, and must produce evidence to the satisfaction of the Council that they :—

(*a*) Have received a good general education and scientific or engineering training, and

(*b*) Have for a sufficient period held an important position of independent responsibility in the practice of engineering production,

(*c*) Or are, by their attainments, deemed by the Council, to be eligible and desirable for membership.

Associate Members.

13. Candidates for admission to the grade of Associate Members, must be persons not under twenty-eight years of age, and must produce evidence to the satisfaction of the Council that they :—

(*a*) Have received a good general education, and scientific and engineering training, and

(*b*) Have for not less than four years been engaged in the practice and science of engineering as applied to production, and hold a position of responsibility at the time of their application for election.

They may on attaining the necessary qualifications, make application to be transferred to the grade of Member.

Intermediate Associate Members.

14. Candidates for admission to the grade of Intermediate Associate Member must be persons not under twenty-eight years of age and must produce evidence to the satisfaction of the Council that they :—

(*a*) Have received a good general education, and engineering training, and

(*b*) Have for not less than four years been engaged in the practice and science of engineering, as applied to production,

and shall be actually engaged in such work at the time of their application for election.

They may on attaining the necessary qualifications make application to be transferred to a higher grade of membership.

Associates.

15. Candidates for admission to the grade of Associate must be persons not under twenty-eight years of age, who, in the absence of the necessary qualifications for Corporate Membership, nevertheless have held for a sufficient length of time positions of authority involving responsibility for Executive Management, or control of any function pertaining to production or who are otherwise considered eligible for election as Associates by the Council. They may on attaining the necessary qualifications make applicaton to be transferred to Corporate Membership.

Affiliates.

16. An Affiliated Firm shall be a Firm or Company interested in engineering as applied to production, or otherwise interested in the objects of the Institution.

An Affiliated Firm shall be entitled to nominate two members of its staff as Affiliates for a subscription of 10 guineas per annum, provided always that such Affiliates shall be approved by Council. For every additional representative the sum of 5 guineas per annum shall be paid. Affiliates shall be entitled to all the privileges of membership except that of voting.

An Affiliated Firm may, if it so desires, use the wording " Affiliated to the Institution of Production Engineers " on its letterheadings, and in its trade announcements, etc., but neither this wording nor the abbreviated title can be used by an Affiliated Firm's nominated representatives.

Graduates.

17. Graduates must be persons not under twenty-one years of age, who can show that they are receiving, or have received, practical training in production engineering, and have passed the Institution's Graduate Examination, or shall be exempt therefrom, by reason of having passed an examination which is considered by the Council to be of an equivalent standard.

Candidates for admission as Graduates who have qualified by examination, but who have not yet attained the age of twenty-one, may attend the meetings of the Institution, but shall not be entitled to vote or be entered in the Register of Members, except as Students, but on attaining the age of twenty-one, may apply to enter as Graduates.

No person shall be elected as a Graduate after the completion of his twenty-seventh year.

Graduates may apply for transfer to a higher grade on attaining the age of twenty-eight years, but may not continue as Graduates beyond the age of thirty-two years, except at the discretion of the Council.

STUDENTS.

18. Students must be persons between sixteen and twenty-five years of age, who are following an approved form of training, and who are considered suitable for election by the Council.

ELECTION OF MEMBERS.

19. Elections shall take place as often as may be desirable, and they shall be made by the Council.

20. An application for admission to the Institution shall be made according to regulations laid down by the Council, and on forms to be approved by the Council; such regulations or forms to be varied at the discretion of the Council.

21. The General Secretary shall forward to each candidate whose application has been considered and approved by the Council a notification of his election on such form as may be approved by the Council, but the applicant's name shall not be added to the register of the Institution until the entrance fee, if any, and first annual subscription shall have been paid. Failure to comply with this article within three months will nullify the election of the candidate.

22. In the case of non-election, no mention thereof shall be made in the minutes.

TRANSFERS.

23. Any Associate Member, Intermediate Associate Member Associate, Graduate or Student desirous of being transferred to a different grade of membership, shall forward to the General Secretary an application according to the regulations laid down by the Council. Such application shall be laid before the Council, at their next meeting, for consideration, and, if approved, the General Secretary shall forward to the applicant a notice of his transfer, on such form as may be approved by the Council. The transfer will be completed upon payment of any difference there may be in subscription.

24. In the case of non-transference, no mention thereof shall be made in the minutes.

RESIGNATION AND EXPULSION.

25. Any Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student notifying the General Secretary, in writing, that he is desirous of withdrawing from the Institution, shall cease to be included in the membership of the Institution, and his name shall be removed forthwith by the Institution, from its register.

26. If any Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student, shall leave his subscription in arrear for one year, and shall fail to pay such arrears within three months, after a written application has been sent to him by the General Secretary, to his last known address, his name may be struck off the register by the Council at any time afterwards, and he shall thereupon cease to be a Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student; provided always that this article shall not be construed to compel the Council to remove any name if they shall be satisfied the same ought to be retained. For the purposes of this article, the subscription of an Affiliated Firm by virtue of which Affiliates are nominated shall be deemed to be the subscription of the Affiliates.

27. The Council may, by a resolution passed at a meeting of the Council by a majority of the whole of the Councillors, refuse to continue to receive subscriptions of any Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student of the Institution who is not in the opinion of the Council a suitable person to continue as such, and may remove his name from the register, and he shall thereupon cease to be a Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student. Provided always that no such resolution shall be passed or have any operation or effect unless the member affected has been given reasonable notice of the meeting and a proper opportunity of being heard in his defence thereat.

28. No member shall abuse his connection with the Institution to further his business interests. Anyone adjudged by the Council to have contravened this Article is liable to be removed from the Register.

ENTRANCE FEES AND SUBSCRIPTIONS.

29. Every new Member, Associate Member, Intermediate Associate Member, and Associate, shall on election, pay an entrance fee, the amount of which shall be equivalent to one years subscription, according to the grade to which he is elected, but no payment, other than the increased annual subscription, shall be due on transference from one grade to another.

30. Each Member shall pay an Annual subscription of £3 3s.

31. Each Associate Member shall pay an annual subscription of £2 12s. 6d.

32. Each Intermediate Associate Member shall pay an annual subscription of £2 2s.

33. Each Associate shall pay an annual subscription of £2 12s. 6d.

34. Each Affiliated Firm shall pay an annual subscription of £10 10s. This amount shall entitle the said Affiliated Firm to nominate two Representatives. For every additional Representative, the sum of £5 5s. shall be paid.

35. Each Graduate up to the age of twenty-five shall pay an annual subscription of £1 1s., and each graduate above the age of twenty-five, shall pay an annual subscription of £1 11s. 6d.

36. Each Student, up to the age of twenty-five shall pay an annual subscription of 10s. 6d., those over twenty-five years of age, shall pay an annual subscription of £1 1s.

37. All subscriptions shall be payable in advance and shall become due on July 1st in each year. Where the term "year" is used in these articles or in connection with any other business of the Institution it shall be deemed to refer to a period from July 1st to June 30th, unless otherwise stated.

38. In the case of Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates, and Students, elected in the last four months of any year, the first subscription shall cover the year of election and the succeeding year.

39. Any Member, Associate Member, Intermediate Associate Member, or Associate whose subscription is not then in arrear, may compound for the then current year and all future years by the payment of 25 guineas or such other amount as may be approved by the Council.

40. All those admitted to the Institution whether as Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student, shall be considered as belonging thereto, until their names shall have been removed by the Institution from its register.

41. No Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student, whose contribution is twelve months in arrear shall be entitled to attend or take part in the meetings of the Institution or to enjoy or exercise any of the privileges of membership.

COUNCIL, CONSTITUTION AND ELECTION OF.

42. The Council of the Institution shall be chosen from Members and Associate Members only, and may not consist of more than one President, one President-Elect, one Chairman of the Council, four Past-Presidents, four Vice-Presidents (who shall be past Chairmen of Council), Section Presidents, twelve elected Members of Council two of whom shall be Associate Members, all Chairmen of Standing Committees and such other members of the Local Sections as may be elected in accordance with Article 79.

The Council shall at the Council Meeting held in May or June approve the names of the officials elected by the Local Sections in accordance with Article 79, or take other action if deemed necessary in the interests of the Institution. At the same meeting the Council shall elect a President of the Institution from among the Honorary Members or Members, excepting that they may waive this qualification in favour of one who by virtue of his eminence in the practice or profession of engineering is considered worthy of the high honour of being made President. At the same meeting the Council shall elect from amongst the present or past members of Council one to act as Chairman of Council for the ensuing Session. The Chairman so elected shall be empowered to perform any function of the office of President of the Institution should the holder of that office or the holder of the office of President-Elect desire to delegate all or any of his functions.

The Council of the Institution shall have power from time to time, if, in their opinion, it is desirable to do so, to co-opt as additional members of the Council not more than three persons, who shall be nominated by any other Society, Corporation, or Body which shall have kindred interests with or further the objects of the Institution. Such additional members shall hold office for such period and on such terms as may be agreed upon by the Council and the nominating body.

43. The first members of the Council shall be: President—Tom Thornycroft; Vice-Presidents—R. W. Bedford, W. G. Groocock, E. W. Hancock, R. B. D. Lauder, W. Pate, H. E. Weatherley. Other members—H. C. Armitage, A. Butler, S. Carlton Smith, P. S. Crooke, H. A. Dudgeon, E. W. Field, G. H. Hales, A. J. Hancock, J. A. Hannay, S. M. Hardaker, T. G. Heckels, Sir Alfred Herbert, G. Hey, R. T. Hutchinson, H. Mantel, R. J.

Mitchell, J. D. Scaife, F. W. Shaw. Until a Chairman of Council shall have been elected under the provisions of Article 42 the Council may elect any member of the Council as Chairman.

44. The President, and Chairman of Council, and six elected Members of Council, shall retire annually, but shall be eligible for re-election, but no President or Chairman of Council shall hold office longer than two consecutive years.

45. The elected Members of Council to retire each year shall, unless the Council agree otherwise among themselves, be chosen from those who have been longest in office, and in case of equal seniority shall be determined by ballot.

46. The Past-Presidents, and the Vice-Presidents to serve upon the Council shall be elected by the Council. They shall retire annually, but shall be eligible for re-election.

47. All duly elected Presidents of Local Sections shall take up office as such, after the date of the Council Meeting held in May or June, referred to in Article 42, and shall then become Members of Council. No President of a Local Section shall hold office for more than two consecutive years.

48. The President, President-Elect, Chairman of Council, Vice-President, and other Members of Council, elected at the annual election, shall take office on the first of July. The Council may fill any casual vacancy on the Council, including any casual vacancy in the office of President or Chairman of Council, which shall occur between one election and another, but anyone so appointed shall retire at the succeeding annual election. Vacancies not filled at any such annual election shall be deemed to be causal vacancies within the meaning of the Article.

49. An election to fill vacancies on the Council shall be held annually in April. Candidates for election as Councillors must be nominated in writing by three Members or Associate Members except in the cases of retiring Councillors willing to stand for re-election and candidates nominated by Section Committees. Each Section Committee may nominate one candidate.

Notice of the election shall be forwarded to all Members, Associate Members, and Intermediate Associate Members at least ten days prior to the latest date fixed for receiving nominations, together with notification of the number of vacancies to be filled, a list of retiring Councillors who intend to seek re-election, and, in the case of the latter, a record of their attendances at meetings of the Council since their previous election. Within three

weeks after the latest date for receiving nominations a ballot paper shall be forwarded to all Members, Associate Members, and Intermediate Associate Members. The ballot paper shall contain the names, business and private addresses, occupations, and honorary titles of the candidates and the names of the members or Section Committees by whom they are nominated, except that retiring Councillors seeking re-election shall not require nomination. The names of those elected to fill the offices of President, and Chairman of Council, together with the names of the Presidents and of the additional representatives of the Local Sections, if any, on the Council shall not be subject to ballot by Members, Associate Members, and Intermediate Associate Members; but the names, addresses, titles, etc., of those so elected, together with the names of the non-retiring Councillors shall be sent to the members with the ballot paper. Members, Associate Members, and Intermediate Associate Members shall be entitled to vote for as many candidates as there are vacancies to be filled, in accordance with the instructions on the ballot paper, as may be determined by the Council from time to time. Only those votes shall be effective which are recorded on ballot papers reaching the General Secretary by a specified date, which shall be a date not less than one week or more than two weeks after the ballot papers have been issued.

50. Candidates for the offices of President and President-Elect shall be nominated in writing by a Member of Council at or before the Council Meeting prior to that at which the election of President and President-Elect takes place.

51. The continuing members of the Council may act notwithstanding any vacancies in the Council. Provided that if the number of members of the Council shall be reduced below five the continuing members may act for the purpose of filling up vacancies in their body or of summoning a general meeting, but for no other purpose.

52. A member of the Council shall vacate his office if he become bankrupt or lunatic or if he ceases for any cause to be a member of the Institution.

PROCEEDINGS, POWERS, AND DUTIES OF THE COUNCIL.

53. The Council shall direct and manage the property and affairs of the Institution, and may regulate their own procedure, except that not less than five Councillors shall form a quorum. Questions arising at a meeting of the Council shall be determined by a majority of votes. Every member of the Council shall have one vote at meetings of the Council, and in the case of an equality of votes the Chairman shall have a second or casting vote. The

Council may pay all the expenses of setting up and registering the Institution, and may exercise all such powers of the Institution and do on behalf of the Institution all such acts as may be exercised and done by the Institution, and as are not by the statutes or by these presents required to be exercised or done by the Institution in General Meeting, subject nevertheless to any regulations of these presents, to the provisions of the statutes, and to such regulations, being not inconsistent with aforesaid regulations or provisions, as may be prescribed by the Institution in General Meeting, but no regulation made by the Institution in General Meeting shall invalidate any prior act of the Council which would have been valid if such regulation had not been made. Provided that the Council may not, without the authority of a resolution of the Institution in General Meeting, borrow moneys for the purposes of the Institution on the security of the property of the Institution or other available security, or otherwise, at their discretion.

54. The Council shall have power to appoint Sub-Councils in any Territories overseas where Sections are established, and may delegate authority to the Sub-Councils to carry out their affairs in accordance with the rules and regulations laid down by the Council.

The Council shall also have power to appoint Standing Committees to deal with :—(*a*) Finance and General Purposes, (*b*) Membership, (*c*) Technical Matters and Publications, (*d*) Research, (*e*) Education, (*f*) Standardisation, (*g*) Library, (*h*) Such other matters as the Council may deem necessary. Such Standing Committees, except in the case of those dealing with Research and Standardisation, shall consist exclusively of members of the Institution, unless otherwise determined by the Council.

The Research Committee shall consist of (*a*) Members, (*b*) Representatives of Affiliated Firms and (*c*) others, provided that the number of those elected under (*a*) and (*b*) shall together form a majority over those elected under (*c*).

Each Standing Committee shall be subject to re-election annually, and will take office from the 1st July. The Council shall have power to delegate to such Committees such powers and authorities as it shall think fit, and shall have power to fill any vacancy which may occur thereon and in its discretion to increase or decrease the membership of any such Committee.

The Council shall appoint a Chairman for any of its Standing Committees from among the members of that particular Committee, or may delegate to the Standing Committee concerned authority to elect a Chairman from among its number. Such Chairman must be an Honorary Member, Member, or Associate Member.

The President, President-Elect, and Chairman of Council shall be *ex-officio* members of all Standing Committees.

55. Technical Groups may be formed by the Council at its discretion, if sufficient evidence is produced as to the demand for the formation of such groups, subject to any such conditions that the Council may specify, and the Technical Group may appoint a Chairman and Committee. The Council shall have power to dissolve any Technical Group at any time after it has been formed.

The Council shall have power to appoint Temporary Committees for special purposes, consisting of (*a*) Members, (*b*) Representatives of Affiliated Firms, and (*c*) others, provided that the number of those elected under (*a*) and (*b*) shall together form a majority over those elected under (*c*), with such powers, (subject to the control of the Council) as the Council may prescribe. The Council shall appoint a chairman for any of its Temporary Committees from among the members of that particular Committee, or may delegate to the Temporary Committee concerned authority to elect a Chairman from among its number. Such Chairman must be an Honorary Member, Member, or Associate Member. The Council shall have power to fill any vacancy which may occur in any Temporary Committee and in its discretion to increase or decrease the membership of any such Committee.

The President, President-Elect, and Chairman of Council shall be *ex-officio* members of all Temporary Committees.

56. Each Standing Committee and Temporary Committee shall have power to appoint Sub-Committees consisting of (*a*) Members (*b*) Representatives of Affiliated Firms, and (*c*) others, provided that the number of those elected under (*a*) and (*b*) shall together form a majority over those elected under (*c*), with such powers (subject to the control of the Committee concerned) as the Committee concerned may prescribe. Each Sub-Committee shall be subject to re-election annually.

The Council shall have power to discharge or suspend at any time any Standing, Temporary, or Sub-Committee or remove any member thereof.

57. It shall be the duty of the Council to adopt all due means for the advancement of the Institution; to provide for properly conducting its business in all cases of emergency; and to arrange for the publication, in such a way as they may deem desirable, of the papers read at meetings of members of the Institution, and discussions thereon, and of such documents as may be calculated to advance production engineering knowledge.

58. No act done by the Council, whether *ultra vires* of the Council or not, which shall have received the sanction of a General Meeting, shall be afterwards impeached by any person included in the membership of the Institution on any ground whatever, but shall be deemed to be an act of the Institution, provided that, though *ultra vires* of the Council, it be within the powers on the Institution.

59. All acts done by any meeting of the Council or a Committee or by any person acting as a member of the Council shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such body or person acting as aforesaid or that they or any of them were disqualified, be as valid as if every such body or person had been duly elected and appointed.

THE SEAL.

60. The Seal of the Institution shall not be affixed to any instrument except by the authority of the Council, and, in the case of all instruments other than membership certificates, in the presence of a Member of Council, and of the General Secretary or other such person as the Council may appoint for the purpose; and that Member of Council and the General Secretary or other person as aforesaid shall sign every instrument (other than membership certificates) to which the Seal of the Institution is so affixed in their presence.

APPOINTMENT AND DUTIES OF OFFICERS.

Trustees and Treasurer.

61. The Council may appoint Trustees, who shall carry out their duties as laid down by these articles. The Treasurer of the Institution shall be appointed, as and when a vacancy occurs, by the Council, shall be removable by the Council upon one month's notice from any day, but in the case of serious negligence may be dismissed without notice. The Treasurer shall give one month's notice in the event of his wishing to resign.

62. The Treasurer shall hold and be responsible for the uninvested funds of the Institution ; shall keep all the accounts necessary and proper for the purposes of the Institution ; shall from time to time submit financial statements at the request of the Council ; and shall pay all moneys into Bank, approved by the Council, upon receipt.

General Secretary.

63. The General Secretary of the Institution shall be appointed by the Council, and they shall determine the terms and conditions of his appointment.

It shall be the duty of the General Secretary, in person or by deputy, under the direction of the Council, to conduct the correspondence of the Institution; attend all meetings of the Council and Committees thereof; take minutes of the proceedings of such meetings; superintend the publication of such papers as the Council may direct; have charge of the Library; and conduct the collection of all subscriptions. He shall also engage and be responsible for all persons employed under him. He shall conduct the ordinary business of the Institution in accordance with these articles and the direction of the Council.

Honorary Secretaries.

64. Honorary Secretaries to Local Sections of the Institution shall be appointed by the Committees of such Sections, subject to the approval of the Council in each case.

Auditors.

65. Duly qualified Auditors shall be elected, and their duties shall be regulated in accordance with Sections 132, 133 and 134 of the Act.

Officials.

66. It shall be left to the Council, as seems expedient to them from time to time, whether all or any of the Officials of the Institution other than the Auditors be engaged for full or part time employment, and to fix their rate of remuneration, if any.

GENERAL MEETINGS.

67. The first General Meeting of the Institution shall be held at such time within not less than one month nor more than three months after the incorporation of the Institution at such time and place as shall be determined by the Council. Subsequent General Meetings shall be held once in each calendar year, which shall be called Annual General Meeting. All other General Meetings shall be called Extraordinary General Meetings.

68. The Annual General Meeting shall take place in London between 1st October and 31st December every year, at such time and place as shall be determined by the Institution in General Meeting or in default of such determination by the Council.

69. An Extraordinary General Meeting may be convened at any time by the Council, and shall be convened by them upon such requisition, or, in default, may be convened by such requisitionists as provided in Section 114 of the Act.

70. The quorum for a General Meeting shall be five members personally present and entitled to vote. In the event of the quorum not being formed within half an hour of the time announced for the commencement of the Meeting, the Meeting, if convened on the requisition of members, shall be dissolved. In any other case it shall stand adjourned to the same day in the next week at the same time and place, and if at the adjourned meeting a quorum is not present within half an hour from the time appointed for the Meeting, the members present shall be a quorum.

71. Subject to the provisions of Section 117 of the Act relating to special resolutions, seven clear day's notice of every General Meeting, specifying the place, day and hour of the meeting and the nature of any special business to be transacted at any General Meeting, shall be given to every person on the Register of Members of the Institution, except as provided by Article 89, and no other special business shall be transacted at such Meeting; but the accidental omission to send such notice to or the non-receipt of such notice by any member, shall not invalidate the proceedings of such Meeting. No notice of the business transacted (other than such ballot lists as may be requisite in case of elections) shall be required in the absence of special business.

72. Special business shall include all business for transaction at an Extraordinary General Meeting, and all business for transaction at an Annual General Meeting, with the exception of the consideration of the accounts and balance sheets and the ordinary reports of the Council and Auditors, and the fixing of the remuneration of the Auditors.

73. The President, or President-Elect of the Institution, or the Chairman of the Council, shall preside as Chairman at every General Meeting of the Institution. If there is no such President, President-Elect or Chairman, or if at any meeting no one of them is present within fifteen minutes after the tine appointed for holding the meeting, or is unwilling to act as Chairman, the members present shall choose someone of their number to act as Chairman.

74. The Chairman may, with the consent of any meeting at which a quorum is present (and shall if so directed by the Meeting) adjourn the Meeting from time to time and from place to place.

75. No person other than Members, Associate Members, and Intermediate Associate Members, shall have the right to vote at any General Meeting of the Institution. Each Member, Associate Member and Intermediate Associate Member shall have one vote, but in the case of an equality of votes, the Chairman of the Meeting shall have a second and casting vote.

76. At any General Meeting of the Institution a resolution put to the vote of the meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the result of the show of hands) demanded by at least two Members, Associate Members, or Intermediate Associate Members present, and unless a poll is so demanded, a declaration by the Chairman that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, or not carried by a particular majority, and an entry to that effect in the minutes of the meeting, shall be conclusive evidence of the fact, without proof of the number of proportion of the votes recorded in favour of, or against, that resolution. If a poll is duly demanded, it shall be taken in such a manner as the Chairman directs, and the result of the poll shall be deemed to be the resolution of the Meeting at which the poll was demanded. The result of the poll shall be reported in the Official Organ of the Institution. No poll may be demanded on the election of a Chairman of a General Meeting or on a question of adjournment, which shall, if necessary, be decided by a show of hands.

LOCAL SECTIONS.

77. Local Sections of the Institution may be formed by the Council, consisting of Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates, and Students of the Institution, in such local centres as afford evidence satisfactory to the Council :—

(*a*) Of a demand for the formation of a Local Section on the part of Members and Associate Members resident in the locality, and

(*b*) That a Local Section, if formed, will be so adequately supported and of such usefulness in the locality that the Council will be justified in appropriating funds of the Institution towards its support.

The Council shall have power to dissolve such Section at any time after it has been formed.

78. The proposal for the formation of a Local Section shall be by petition of the Members, Associate Members, and Intermediate Associate Members, resident in the locality or otherwise at the discretion of the Council. Such petition, together with the evidence as to the probable support and usefulness of the proposed Section, shall be brought before and considered by the Council, and if they decide that the Section shall be formed, a first Meeting of the Members, Associate Members, Intermediate Associate Members, Associates, Affiliates, Graduates and Students, resident in the locality shall be convened by written notice specifying generally the nature of the business to be transacted.

This Meeting shall be under the Chairmanship of a Member of the Council.

79. A President of the Section (chosen from the Members only) and a Committee (chosen from the Members and Associate Members) shall be appointed by resolution of the Members, Associate Members, and Intermediate Associate Members on the register of the Section at the first Meeting of the Section. The President and Committee shall manage the local affairs of the Section subject to the approval of the Council. To ensure proportional representation on the Council, the President shall become a member of Council in accordance with Article 47, and be the Representative of the first 200 members of the Section. A further member of the Committee may be nominated as a Member of Council, where the membership exceeds 200, and a third member, where the membership exceeds 400. No Section shall have more than three Representatives, inclusive of the Section President.

The President and at least one third of the Committee, including the additional representatives to the Council, if any, shall retire at each Annual Meeting of the Section. All members shall be eligible for re-election, except that, as provided in Article 47, no President of a Local Section shall hold office for more, than two consecutive years. Casual vacancies in the office of President or in the Committee may be filled by the Committee but those so appointed shall retire at the succeeding Annual Meeting of the Section. The election of a President and members of the Committee (qualified as above) to fill the place of those retiring shall be conducted in the manner prescribed by the articles from time to time in force, as provided by Article 80.

80. Each Local Section shall be constituted and its affairs shall be carried on in accordance with rules and regulations laid down from time to time by the Council, and the election of officers for the ensuing year shall be held not later than March each year.

A Local Section Committee may, if it considers it desirable, propose to the Council, the establishment within the Area of the Section, as defined by the Council, one or more Sub-Sections. Any Sub-Section, so established by the Council, shall elect a Committee, which will operate under the general supervision of the Section Committee for its area, and shall be subject to such rules and regulations as may be laid down from time to time by the Council.

81. The appropriation and contribution of funds of the Instititution towards the expenses of Local Sections, or to enable such Local Sections to co-operate with Sections of other Institutions

and Technical and Scientific Societies in the same Locality for the purpose of forming Local Associations for the acquisition of Local Technical Libraries and Meeting Rooms and the provision of staff and equipment thereat for the common use of such Local Sections and Societies, consistently with the objects of the Institution, shall be in the sole discretion of the Council and the Institution shall not be responsible for any liability incurred by or on behalf of any Local Section of the Institution or by or on behalf of any such Local Association beyond any amount previously appropriated or contributed for any such specified purpose by the Council.

KINDRED ASSOCIATIONS.

82. The Council may, subject to ratification by a majority of at least two thirds of those present at an Extraordinary General Meeting convened for the purpose, attended by not less than fifty Members, Associate Members, and/or Intermediate Associate Members, and subject to the restrictions imposed by the Memorandum of Association, arrange for the union, alliance, or incorporation with the Institution of any Society with kindred objects ; and may also, if they think fit, remit or reduce the entrance fees of the Members of such Society at the time of the union, alliance, or incorporation. The Council may, also, at their discretion, and without requiring ratification at an Extraordinary General Meeting, arrange (subject to the restrictions aforesaid) for the affiliation of other Engineering Associations or Societies, and make such regulations in regard thereto as they may deem fit, provided that such affiliation shall not entitle the members of any Engineering Association or Society so affiliated to membership of the Institution.

PROPERTY AND FUNDS.

83. Any donation may be accepted by the Council and Treasurer in aid of the funds of the Institution.

84. All the moneys of the Institution in excess of such current balance in the hands of the Treasurer as the Council shall from time to time require the Treasurer to keep in hand to meet the current expenses of the Institution, shall be invested subject to the provisions of the Memorandum of Association.

85. Every paper presented to the Institution, and accepted for reading or for publication in the " Proceedings," and the copyright thereof, shall be the property of the Institution, unless there shall have been some previous arrangement to the contrary. But the Council, in such cases as they may think fit, shall have power to

release or surrender their rights in respect of any such paper or the copyright thereof.

86. Each Councillor shall be accountable in respect of his own acts only, and shall not be accountable for any acts done or authorised to which he shall not have expressly assented. No Councillor shall incur any personal liability in repsect of any loss or damage incurred through the act, matter, or thing, done, authorised, or suffered by him, being done in good faith for the benefit of the Institution, if believed by him to be within, although actually in excess of, his legal power. But the provisions of this Article are subject to the provisions of Section 152 of the Act.

NOTICES.

87. A notice may be served by the Council or General Secretary of the Institution upon any Honorary Member, Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student, either personally or by sending it through the post in a prepaid letter addressed to such Honorary Member, Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate, or Student, at his address, as registered in the books of the Institution.

88. Any notice, if served by post, shall be deemed to have been served on the day following that on which the letter containing the same was put into the post; and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed and put into the Post Office.

89. No Honorary Member, Member, Associate Member, Intermediate Associate Member, Associate, Affiliate, Graduate or Student not having a registered address within the United Kingdom, shall be entitled to any notice; and all proceedings, may be had and taken without such notice to such Honorary Member, Associate Member, Intermediate Associate Member, Graduate, Associate, Affiliate or Student in the same manner as if he had had due notice.

90. The Institution may name a periodical as the Official Organ of the Institution, for the publication of general notices and other information at the discretion of the Council.

91. After seven clear days from the date of publication any notice published in the Official Organ of the Institution shall be deemed to have been served on all Members.

ACCOUNTS.

92. The Council shall cause proper books of accounts to be kept with respect to :—

(*a*) The assets and liabilities of the Institution.

(*b*) The sums of money received and expended by the Institution and the matters in respect of which such receipts and expenditure take place ; and,

(*c*) All sales and purchases of goods by the Institution.

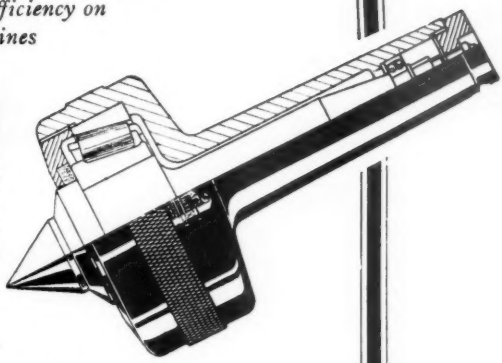
93. The books of accounts shall be kept at the office, or at such other place or places as the Council shall think fit, and shall always be open to the inspection of the members of the Council.

94. The Institution in General Meeting may from time to time make reasonable conditions and regulations as to the time and manner of the inspection by the members of the accounts and books of the Institution, or any of them, and subject to such conditions and regulations the accounts and books of the Institution shall be open to the inspection of members at all reasonable times during business hours.

95. Once at least in every year the Council shall lay before the Institution in General Meeting an income and expenditure account for the period since the last preceding account or in the case of the first account since the incorporation of the Institution, made up to date not more than four months before such meeting together with a balance sheet made up to the same date. Every such balance sheet shall be accompanied by a report of the Council and a report of the Auditors, and a copy of such account, balance sheet and reports shall, seven days before the meeting, be sent to all persons entitled to receive notices of General Meetings, in the manner in which notices are hereinbefore directed to be served. The Auditors' report shall be read before the meeting, as required by Section 129 of the Act.

"IT'S THE CENTRE THAT CARRIES THE LOAD"

Here are two centres designed and proved by tests to give greater efficiency on modern Production Machines



'ARCHER'

ROLLER AND BALL BEARING

REVOLVING CENTRE

is constructed to stand up to the higher speeds and heavier cutting loads which modern cutting tools and machines demand. Its special features are:

1.—Short overhang.
2.—Fully protected bearings.
3.—Centre spindle with bearings both ends.

The 'ARCHER' SUPER-CENTRE

FITTED WITH HIGH SPEED STEEL INSERT

HIGH SPEED STEEL is ideal for Lathe Centres because it stands up against the friction-heat without disintegrating. Wear is reduced to a minimum, and the centre can be reground equal to new without the need of rehardening. The "ARCHER" Super-Centre has now become the standard in many efficiently equipped works.

● **Write today for full particulars**

ARCHER SMALL-TOOLS

FRANK GUYLEE & SON, Ltd.

'ARCHER' TOOL WORKS, MILLHOUSES · SHEFFIELD, 8

Type "T"

TWO STAGE

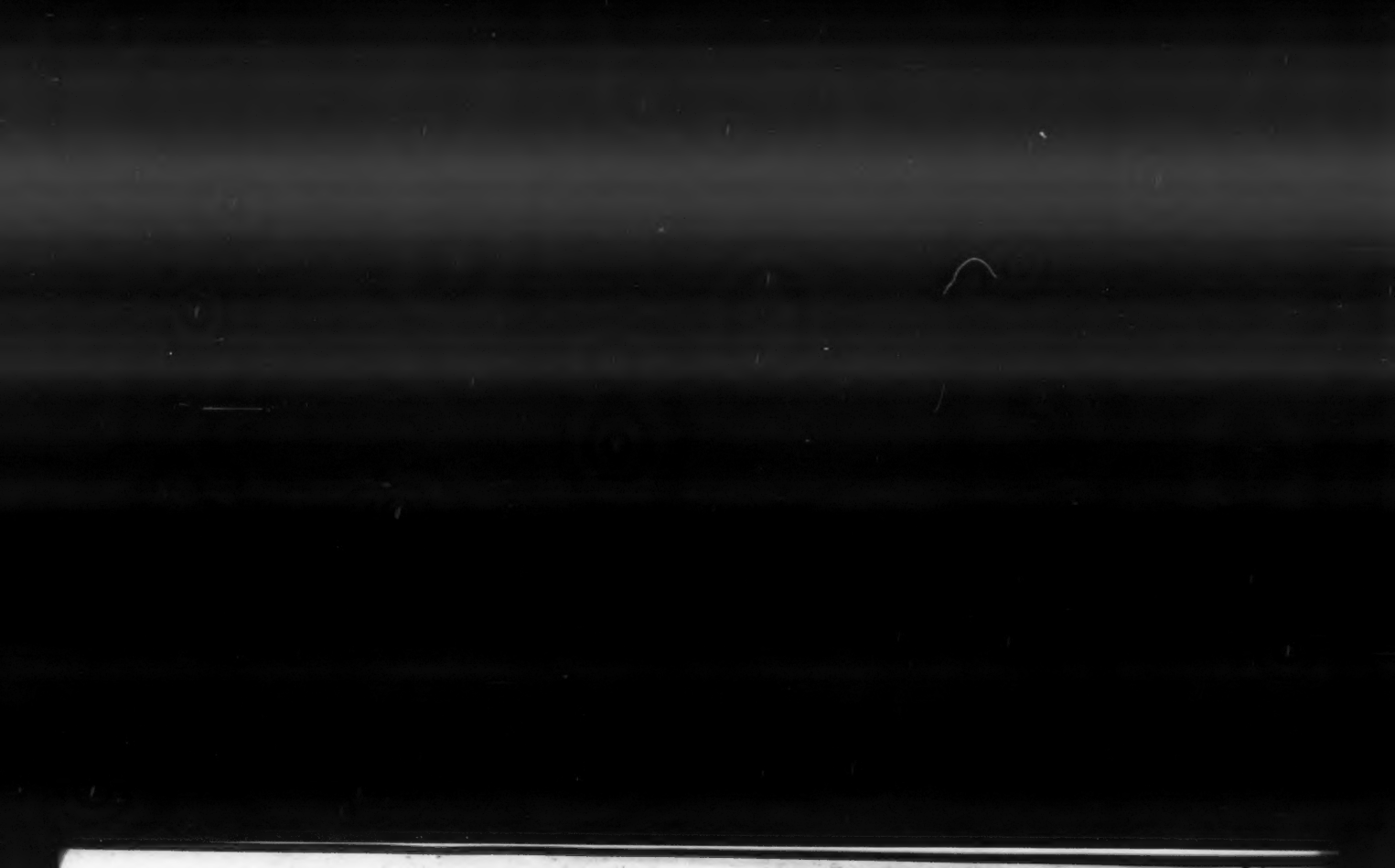
COMPRESSORS

SUPPLY THE AIR

Reproduced by courtesy of
Messrs. Robert Hyde & Son, Ltd.,
North Stafford Steel Foundry, Stoke-on-Trent

Holman BROS. LTD.

CAMBORNE - - ENGLAND

Phone: Camborne 2275 **Grams: "Airdrill, Camborne"**
LONDON OFFICE - - - BROAD STREET HOUSE, E.C.2.

All communications regarding advertisements should be addressed to the Advertising Manager, T. G. Scott & Son Ltd., Talbot House, 9, Arundel St., London, W.C.2. Phone : Temple Bar 1942.
Printed by Richard Bates Limited, 9-13, Stockton Street, All Saints, Manchester 15.